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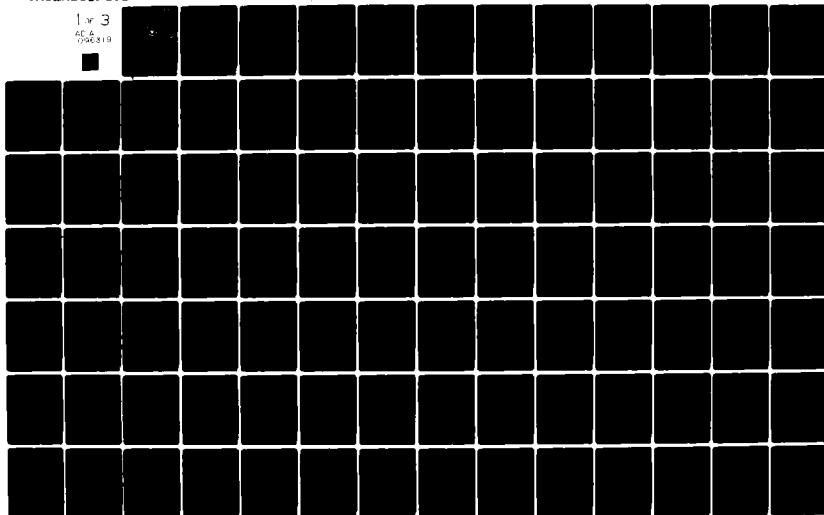
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AN ANALYSIS OF THE USE OF MERCHANT SHIPS
AND CONTAINERIZATION IN AN AMPHIBIOUS OPERATION

by

Paul Joseph Bourdon

December 1980

Thesis Advisor: R.A. Bobulinski

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An Analysis of the Use of Merchant Ships
and Containerization in an Amphibious Operation

by

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MASTER OF SCIENCE IN MANAGEMENT

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ABSTRACT

This study analyzes the use of merchant ships and containerization in an amphibious operation. Current sources, trends and problems, as they affect the merchant marine's ability to provide military logistical support to amphibious operations are evaluated. The functional capability of the various types of merchant ships to perform in an amphibious environment are analyzed. Modern concepts for solving the vehicle and container discharge problem from merchant ships are described and evaluated. The current Marine Corps Container System is analyzed for its compatibility with shipping assets and container handling/motor transport equipment. The study concluded that there are many problems when considering the use of merchant ships and containerization in an amphibious operation. These include the shortage of adequate shipping and the inability to efficiently handle containers in an amphibious environment. Among the several recommendations presented are: first, that military planners must establish the number and type of merchant ships required for large scale amphibious operations and work to ensure their availability and second, that the development and purchase of containers and container offloading equipment for use in an amphibious objective area be expedited.

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LIST OF ABBREVIATIONS

AE	Assault Echelon
AFOE	Assault Follow-On Echelon
ANSI	American National Standards Institute
AOA	Amphibious Objective Area
ATF	Amphibious Task Force
BLT	Battalion Landing Team
CATF	Commander Amphibious Task Force
CEL	Naval Civil Engineering Laboratory
CIA	Central Intelligence Agency
CIWS	Close In Weapons System
COD	Crane-on-Deck
COMM/ELECT	Communication/Electronics
cu. ft.	cubic feet
DOD	Department of Defense
EUSC	Effective United States Control Fleet
FMF	Fleet Marine Force
FOS	Full Operating Status
ft.	foot, feet
FY	Fiscal Year
GAO	General Accounting Office
HLH	Heavy Lift Helicopter
in.	inch
IOS	International Organization for Standardization
JCS	Joint Chiefs of Staff

kn.	knot
kw.	kilowatt
LACH	Light Amphibious Container Handler
LASH	Lighter Aboard Ship
lb.	pound
LCAC	Landing Craft Air Cushion
LCdr	Lieutenant Commander
LCM	Landing Craft, Mechanized
LKA	Amphibious Cargo Ship
LOTS	Joint Logistics-Over-the-Shore
LPD	Amphibious Transport Dock
LSA	Logistics Support Area
LSD	Dock Landing Ship
LST	Tank Landing Ship
LVTP7	Landing Vehicle Tracked Personnel
MAF	Marine Amphibious Force
MAGTF	Marine Air Ground Task Force
MARAD	Maritime Administration
MAU	Marine Amphibious Unit
MCCS	Marine Corps Container System
MHE	Material Handling Equipment
MO-MAT	Motor Transport Matting
mph	miles per hour
MPS	Maritime Prepositioning Concept
MSC	Military Sealift Command
MSTS	Military Sea Transportation Services

M52/M127	M52 Truck with an M127 Trailer
M60AVLB	Armored Vehicle Launched Bridge
NATO	North Atlantic Treaty Organization
NAVAIR	Naval Air Systems Command
NCSL	Naval Coastal Systems Laboratory
NDRF	National Defense Reserve Fleet
NSA	National Shipbuilding Authority
OSDOC II	Offshore Discharge of Containerships
psi	per square inch
RDF	Rapid Deployment Force
Ro/Ro	Roll on/Roll off
RRF	Ready Reserve Force
SALT II	Strategic Arms Limitation Treaty II
sq. ft.	square feet
TCDF	Temporary Container Discharge Facility
T/E	Table of Equipment
TTT	Transamerican Trailer Transport Company
US	United States
USA	United States Army
USAF	United States Air Force
USN	United States Navy
USNS	United States Navy Ship

GLOSSARY OF TERMS

1. Amphibious Force - A naval force and landing force, together with supporting forces that are trained, organized, and equipped for amphibious operations.
2. Amphibious Objective Area - A defined geographical area within which is located an objective to be captured or reached by the land force. This area is defined by competent authority for purposes of command and control. In amphibious operations, the objective area is delineated in the initiating directive in terms of sea, land, and air space.
3. Amphibious Operation - An attack launched from the sea by naval and landing forces, embarked in ships or crafts involving a landing on a hostile shore.
4. Amphibious Shipping - Organic Navy ships specifically designed to transport, land, and support landing forces in amphibious assault operations and capable of being loaded or unloaded by naval personnel without external assistance in the amphibious objective area.
5. Amphibious Task Force - The task organization formed for the purpose of conducting an amphibious operation. The amphibious task force always includes Navy forces and a landing force, with their organic aviation, and may include merchant ships.

6. Amphibious Task Force Commander - The Navy officer designated in the initiating directive as commander of an amphibious task force.
7. D-day - The day of the initial landing (D+5 would be five days after the initial landing).
8. Floating Dumps - Emergency supplies preloaded in landing craft, barges, amphibian vehicles or landing ships. Floating dumps are located in the vicinity of the appropriate control officer who directs their landing as requested by the troop commander concerned.
9. Intermodal Ships - These are containerships, barge ships and roll on/roll off ships. They vary in size, types of cargo handled and cargo capacity.
10. Lighter - A landing craft or barge employed in an amphibious operation, and used for carrying troops, equipment and/or cargo from ship-to-shore.
11. Logistic Support Areas - Those areas ashore which contain the necessary supplies, equipment, installations, and elements which are required to support the landing force logistically throughout the operation.
12. Mothballed - Refers to ships docked and not utilized primarily for cost conservation. However, they are maintained and preserved in order that they may be reactivated within a prescribed time frame when needed.
13. Pendulation - The swinging back and forth of containers suspended from helicopters, lighter-than-air vehicles and/or the boom of cranes.

14. Seastate 1 - Sea condition with waves up to one foot high.
15. Seastate 2 - Sea condition with waves from one to three feet high.
16. Seastate 3 - Sea condition with waves from three to five feet high.
17. Seastate 4 - Sea condition with waves from five to eight feet high.
18. Stevedore - A person employed in the loading or unloading of ships.
19. Tare Weight - The weight of a container that is deducted from the gross weight to obtain net weight.
20. Tramp Fleet - That segment of the merchant fleet which does not adhere to a schedule of sailings, but rather generally seeks cargo which moves in large bulk lots.

I. INTRODUCTION

A. BACKGROUND AND PERSPECTIVE ON THE NEED FOR MERCHANT MARINE SHIPPING IN AN AMPHIBIOUS OPERATION

1. United States Marine Corps (USMC) Mission and Organization

The USMC is responsible for developing warfare doctrine, tactics, techniques, and equipment for use in amphibious operations.¹ Key provisions of the National Security Act of 1947 state that:

The Marine Corps, within the Department of the Navy, shall be so organized as to include not less than three combat divisions and three air wings, and such other land combat, aviation, and other services as may be organic therein. The Marine Corps shall be organized, trained, and equipped to provide fleet marine forces of combined arms together with supporting air components for service with the fleet in the seizure and defense of advanced naval bases and for the conduct of such land operations as may be essential to the prosecution of a naval campaign.²

The USMC's peacetime structure consists of three active and one reserve Marine Amphibious Force (MAF). Each MAF consists of an infantry division, a force service support group and an aircraft wing. The force service support group's primary responsibility is to provide logistical support to the division and wing.

An amphibious assault involves projecting force from the sea, powerful enough to take and control the beach and displace shore defenders. Once this is accomplished, a beachhead is developed and offensive action is mounted inland toward an ultimate objective.

In order to conduct an amphibious assault, the MAF serves as a reservoir of resources for use in establishing a Marine air/ground task force. A task force can be any size; however, it would typically fall into one of the three structures outlined in Table I-1.

The USMC's active forces are deployed as follows:

- a. a MAF is based on the East Coast for use in contingencies in the Atlantic hemisphere.
- b. a second MAF is deployed in the Western Pacific (Japan and Okinawa) to support U.S. policy in the Pacific hemisphere and Indian Ocean.
- c. a third is based on the West Coast and functions as a "swing force" for deployment anywhere, in the Pacific or Atlantic.³

2. Need for Amphibious Force Today

In a recent article in the Marine Corps Gazette, Lieutenant Commander (LCdr) Carl Doublas, United States Navy (USN) stated that the office of the Chief of Naval Operations has acknowledged the U.S. naval amphibious mission is the lowest priority, but the highest in probability of occurrence.⁵

An examination of recent world news events reveals the reasons for LCdr Douglas' statement. The Soviet Union is acting with a decreasing regard for the interests, concerns and sensitivities of the American people. Consider the following events that took place in 1979.

...the USSR supports 45,000 proxy Cuban troops in Africa, principally in Angola and Ethiopia; it seeks to inflame fanatical anti-American mobs in Iran; KGB officers were, in effect, accomplices in the murder of the U.S. Ambassador to Afghanistan earlier this year; top Kremlin leaders threaten America's NATO partners for even considering stationing Pershing II and ground-launched cruise missiles on their territories as a counter to the new Soviet SS-20 mobile missiles and Backfire bombers targeted against them; and the same Kremlin leaders have had the temerity to warn the U.S. Senate against rejecting SALT II, a treaty which opponents say would codify U.S. military superiority...⁶

To add to the list, Soviet tanks and troops moved across its border into neighboring Afghanistan. The Soviets have reached an estimated strength of 80,000 military personnel there.

Adding to the increasing importance of the Indian Ocean and Persian Gulf on the list of America's strategic concerns is the taking of U.S. citizens as hostages at the U.S. Embassy in Tehran, Iran. This situation does not appear to have any immediate resolution and has potential for military intervention.

In 1979, there were also national security problems closer to the borders of the U.S. In Cuba, there was the Central Intelligence Agency (CIA) confirmation of a Russian Combat Brigade of 2000 to 3000 men, equipped with tanks and artillery. The Soviets have stated that the troops had been there as a training unit since the 1962 Cuban Missile Crisis and that they had no intention of leaving.

Concurrently, the Sandinistas, supported by Cuban and Panamanian arms and materiel, were exerting control over

Nicaragua. They forced pro-U.S. dictator, Anastasio Somoza, to flee.

In October of 1979, due to the Panama Canal treaty, the U.S. turned over several military bases and facilities to Panama, significantly decreasing American military presence in Central America.

Aside from pro-Cuban governments in Panama and Nicaragua, Fidel Castro, Cuba's leader, is determined to spread his influence over island states in the West Indies. He has also demanded Puerto Rico's independence from the U.S.

On the other side of the world, there have been some very notable events taking place. A 1979 United States Army (USA) intelligence report stated that North Korea has a significantly higher number of troops than was previously believed. There was also news of the assassination of President Park Chung Hee, the President of Korea.

In 1979, Soviet warships docked at Cam Ranh Bay and Da Nang in a reaction to the Republic of China's campaign across the Vietnam border. Both these ports were major U.S. installations during the Vietnam War and were built at considerable expense to the U.S. government. In the early 1980's, Vietnamese troops have moved across the borders of Cambodia into Thailand, in pursuit of Cambodian guerrillas. This has caused the U.S. to react with increased shipments of military supplies to the Thai government.

Many of the actions that President Carter has taken to counter moves against U.S. interests in 1979 and the early 1980's involved U.S. Naval Forces. He sent the USS Constellation (CV 64) with 85 airplanes to the Arabian Sea/Persian Gulf when pro-Soviet South Yemen attacked North Yemen. He ordered the USS Kitty Hawk (CV 63) and her battlegroup to the Arabian Sea to join the other carrier USS Midway (CV 41) and five other USN ships. Aboard these naval ships was a reinforced Marine battalion landing team (BLT) with tanks and artillery, capable of mounting an amphibious assault.

President Carter also called on the USMC and the USN in the Caribbean. Approximately 2000 Marines were loaded aboard ships in Morehead City, North Carolina, and sent on an amphibious exercise to the U.S. Naval Base, Guantanamo Bay, Cuba. The exercise received extensive coverage by the news media, and the USMC carried out the amphibious landing without a flaw. Both the Russian and Cuban governments monitored the exercise with great interest.⁷

President Carter, frustrated by Russia's refusal to change the status quo in Cuba, talked of speeding up the organization of a rapid deployment force. He also wanted U.S. airlift and sealift capabilities improved. It is projected that Diego Garcia, a 15-mile long tropical island in the middle of the Indian Ocean, will play an important part in the newly created Rapid Deployment Force (RDF). Pentagon officials have indicated that at least one 16,500-man Marine brigade of the three will be assigned to the Indian Ocean.⁸

Seven pre-positioned cargo ships having 30-days worth of USMC equipment aboard would be deployed there.⁹ The cargo ships are part of the maritime prepositioning concept (MPS). The MPS, a major development in 1980, calls for each Marine brigade to be supported by multi-purpose cargo ships, prepositioned in potential trouble spots. General R.H. Barrow, Commandant of the Marine Corps, cautioned that although maritime prepositioning has many advantages, it does not eliminate the continuing need for an amphibious assault capability.

General Barrow states:

One cannot assume that you will have a benign environment where the marriage of the personnel and the equipment takes place. If you can in some sort of administrative fashion, position yourself where you are needed, how wonderful! But in the absence of any assurance, one must be prepared for a forcible entry.¹⁰

The events of 1979 and thus far in 1980 indicate that there are indeed many possible arenas for future confrontation. This places an additional premium on strategic mobility of U.S. Naval Forces. Political and economic opposition to costly overseas basing and international problems in renewing defense agreements are likely to continue.

3. Role of Airlift

Speaking before the 1977 Worldwide Strategic Mobility Conference, Lieutenant General Maurice Casey, USA, Director of Logistics for the Joint Chiefs of Staff (JCS) states:

the role and influence of the U.S. must be based on a powerful central reserve and the strategic mobility that modern technology permits us. Central reserve without mobility and the ability to fight on arrival in overseas areas present

no capability, are ineffective, and are not worth their cost.¹¹

With the advent of the jumbo jet and related technology, airlift has become a viable partner to strategic sealift. Military planners are cognizant of the impact and are committed to the development of the U.S.' airlift capability. Their approach to date has been creative, comprehensive and ambitious. By reducing the equipment which accompanies advanced assault units, prepositioning materiel, and exploiting host country support in certain contingencies, initial lift needs have been substantially reduced. "Substantially" however, does not equate to "significant" in terms of total figures. Even the most optimistic estimates limit the expanding airlift capacity to no more than ten percent of the lift requirements in the near future.¹² The large size of a MAF makes it infeasible to transport by air.¹³

If the world situation required the projection of a MAF onto foreign soil, sealift would still be the primary mode of transportation.

4. Status of Amphibious Shipping

In order to be able to conduct amphibious warfare, the USMC is heavily dependent on the USN's shipbuilding budget. In his annual posture statement on Capital Hill early in 1979, General Louis H. Wilson, the Commandant of the Marine Corps at the time, painted a very gloomy picture of the current situation for amphibious shipping: "the current five year defense plan shows an already reduced

amphibious lift capability that further declines through FY1984 to a total lift of only 1.15 Marine Amphibious Forces."¹⁴

General Wilson pointed out that with the events of 1979, the need to strengthen the USN/USMC amphibious team is even more crucial now than when he sounded the alarm a year earlier. Even if a start were made in next year's fiscal year (FY) 1981 budget, three ships a year would have to be built to maintain a lift capability of 1.15 MAF's. General Wilson stated:

Our amphibious lift capability has shrunk dramatically during the past 15 years or so. The amphibious ship force level, for example, has decreased from 133 ships in 1962 to a total of 66 ships today. Unless these aging ships are replaced, that number would dwindle to only six by the year 2002.¹⁵

Between 1990 and 2002, 53 more amphibious ships are due to retire. "I would assess the impact at that time..." Wilson said at another point in his testimony, "...as unacceptable in regard to national security."¹⁶

Table I-2 shows the amphibious ship breakdown by type as of September 1980. The probable retirement dates of these ships is also included. Also to be considered when addressing the availability of USN amphibious ships are (a) deployment results in roughly a 50-50 split between Pacific and Atlantic ports and (b) about 30 percent of these ships are in maintenance and, therefore, not immediately operational.¹⁷ The USN assumes that ships undergoing overhaul could be available for use in 30 days after mobilization. Ships in the Pacific

Ocean would require 26 days to reach the Atlantic ports under optimal conditions.¹⁸

The procurement picture for amphibious shipping in the future is also dismal. Initial procurement of the dock landing ship (LSD)-41 class has been postponed for seven years.

In 1974 the Navy formalized the requirement to replace its inventory of eight LSD-28 class ships which would reach the end of their 30-year service life between 1948-87. The original plan called for a one-for-one replacement of each LSD to be called the LSD-41. Procurement of the lead LSD-41 was scheduled for FY78 with one ship each in FY's 79 and 80, two in FY81 and the remaining three in FY83. But before the plan could be implemented, fiscal limitations, coupled with a general deemphasis on the need to build amphibious ships caused the program to be continually altered and delayed each year that it was proposed. The FY80 budget submitted to the President and subsequently to the Congress was no exception, it contained no LSD-41.¹⁹

The five-year shipbuilding plan for FY's 80-84 submitted by Secretary of Defense Harold Brown to Congress did not include any LSD-41's or for that matter any other amphibious ships.

The difficulty is partly one of cost. The high price of ships has caused the Carter administration to postpone building programs. Current plans are to build up and modernize U.S. air and ground units assigned to the North Atlantic Treaty Organization (NATO) central front in Europe. Funding for the buildup has caused corresponding reduction in the USN and USMC forces around the world. Among the hardest hit units are the amphibious forces.

B. PROBLEM DEFINITION

As presented in the previous section, the world situation today requires that the U.S. have the capability to lift a large MAF for the conduct of an amphibious operation on foreign soil. The United States Air Force (USAF), although continually improving, does not have the capacity to lift a force the size of a MAF.

Neither the previous administration nor the present one has put amphibious shipping very high on the priority list. Therefore, the future of the already reduced amphibious lift capability of the USN is not very promising for the USMC. With a continued increase of world tension and restricted resources, what alternative means do the USN/USMC have to solve the problem of reduced lift capability? This is the general problem that this thesis will address.

C. OBJECTIVES

The capability of the USN/USMC to utilize merchant ships in an amphibious operation to supplement the USN's reduced amphibious lift capability will be examined.

Since containerships compose an ever growing percentage of today's merchant fleet, a secondary objective will be to examine the use of containerization as a radical change from the conventional breakbulk cargo in an amphibious objective area (AOA).

D. GENERAL APPROACH AND METHODOLOGY

The research for this thesis was accomplished by the following methods:

1. literature search.
2. data collection (actual studies being accomplished by the Marine Corps Development Command, Quantico, Virginia, and the Civil Engineering Laboratory, Port Hueneme, California).
3. interviews with personnel currently involved with ongoing studies relative to the use of merchant ships and containers by the USN/USMC.
4. on site examination of the testing being conducted at the Civil Engineering Laboratory, Port Hueneme, California.

The composition and characteristics of the past, present and future merchant fleets are presented. There is specific emphasis on the offshore discharge of cargo problem characteristic of a USN/USMC amphibious operation.

Finally, there is a detailed analysis of the impacts, requirements and progress of containerization as a means of packaging cargo to be utilized by the USMC in an amphibious operation.

E. THESIS CHAPTER SUMMARY

The first chapter introduces the reader to the mission and organization of the USMC, the need for an amphibious force in today's environment, the problem of reduced

amphibious lift capability of the USN, and the author's objectives and research methodology.

Chapter II discusses the development, trends and problems of the U.S. merchant fleet.

Chapter III analyzes the functional characteristics of merchant ships and their suitability to perform specialized tasks in support of a USN/USMC amphibious operation.

Chapter IV examines the offshore discharge problem that evolves from the use of merchant ships in an amphibious operation and the progress of current developments to solve the problem.

Chapter V analyzes the impact and requirements of containerization as it relates to use by the USMC in an amphibious operation. The types of containers being developed and the tactical consideration of their use will be presented. Also current trends and project status in containerization will be discussed.

Finally, in Chapter VI the author summarizes his findings and makes recommendations for future consideration.

Although an attempt has been made to avoid technical terminology whenever possible, there are words utilized in this thesis that may be unfamiliar to some readers. For this reason, a glossary of terms is provided.

Marine Air/Ground Task Forces

<u>Tactical unit</u>	<u>Marine Amphibious Unit</u>	<u>Marine Amphibious Brigade</u>	<u>Marine Amphibious Force^a</u>
Commander:	Colonel:	Brigadier General:	Lieutenant General:
Components:			
Ground	Battalion Landing Team	Regimental Landing Team	Marine Infantry Division
Air	Composite Helicopter Squadron	Aircraft Group	Marine Aircraft Wing
Support	Logistics Support Unit	Logistics Support Group	Force Service Support Group
Profile:			
Troop complement	1,600-4,000	6,000-18,000	40,000-50,000
Tactical aircraft	As required	45-65	125-175
Helicopters	20-36	75-100	175-225
Tanks	5-10	17-34	70-140
Artillery pieces	6-12	24-42	75-100

^{a/} A MAF may have more than one Marine Division and more than one Marine Aircraft Wing.

Table I-1

Source: Marine Amphibious Forces: A Look at Their Readiness, Role, and Mission, p. 3.

1980 Amphibious Ship Force

Ship Class	Name	Number of Active Ships	Probable Retirement Date			
			1984- 87	1991- 97	1999- 2003	2007- 10
LSD-28	Dock Landing Ship	8	8			
LPH-2	Amphibious Assault Ship	7		5	2	
LPD-1	Amphibious Trans- port Dock	2		2		
LPD-4	Amphibious Trans- port Dock	12		5	7	
LKA-113	Amphibious Cargo Ship	2			2	
LSD-36	Dock Landing Ship	5			5	
IST-1179	Tank Landing Ship	20			20	
LCC-19	Amphibious Command Ship	2			2	
LHA-1	Amphibious Assault Ship, General Purpose	5				5
Total		63	8	12	38	5

Table I-2

Source: Marine Corps Gazette, p. 40.

II. UNITED STATES MARITIME INDUSTRY, DEVELOPMENT TRENDS AND PROBLEMS

A. INTRODUCTION

Chapter I of this study pointed out the significant decline of United States Navy (USN) amphibious shipping over the past 15 years. In large scale amphibious operations of the future, the USN and USMC will be dependent upon the U.S. Merchant Marine as a vital component of the amphibious task force (ATF). The term U.S. Merchant Marine refers to commercial ships, under private ownership, sailing under the U.S. flag. In order to provide some background information on the U.S. Merchant Marine, this chapter will present:

1. the development of the U.S. Merchant Marine with regard to defense needs.
2. the U.S. government maritime support programs that have been established to ensure the U.S. Merchant Marine as a viable naval auxiliary in time of war.
3. organizations formed to provide a source of merchant ships needed to support a military contingency.
4. the trends and problems of the U.S. Merchant Marine as they exist today.

B. SEALIFT DEVELOPMENT

The importance of sealift in the security of the U.S. was recognized very early by national leaders. In 1778, the First Congress of the U.S. passed legislation to protect and

develop the U.S. Merchant Marine. The U.S. has had to rely heavily on merchant marine sealift capability in every war from World War I to Vietnam.¹

At the beginning of World War I, the American merchant fleet was virtually non-existent. As a result the government was faced with a massive ship building effort. The Emergency Fleet Corporation and the War Shipping Board were established in 1916. These agencies were tasked with accelerating the buildup of both the United States Army (USA) and USN fleets, resulting in contracts for 3,200 ships in the period between 1916 and 1919.²

Prior to World War II, the nation was faced with a similar situation. The large force built as a result of World War I had been neglected and was close to obsolescence. As a result, Congress enacted the Merchant Marine Act of 1936. The policy of the U.S. government concerning the merchant marine is stated in the opening section of this Act:

It is necessary for the national defense and development of its foreign and domestic commerce that the United States shall have a merchant marine (a) sufficient to carry its domestic water-borne commerce and a substantial portion of the water-borne export and import foreign commerce of the United States and to provide shipping service on all routes essential for maintaining the flow of such domestic and foreign water-borne commerce at all times, (b) capable of serving as a naval and military auxiliary in time of war or national emergency, (c) owned and operated under the United States flag by citizens of the United States insofar as may be practicable, and (d) composed of the best-equipped, safest, and most suitable types of vessels, constructed in the United States and manned with a trained and efficient citizen personnel. It is hereby declared to be the policy of the United States to foster the development and encourage the maintenance of such a merchant marine.³

The Merchant Marine Act of 1936 established the Maritime Commission which was chartered to develop a national program promoting the merchant marine. The commission developed a ten-year program to build 500 new merchant ships. This program was starting when World War II began.⁴

The U.S. entered World War II with both the USA and USN retaining their individual ocean shipping capability. Throughout the war, the two services remained separate despite an effort in 1942 to combine the USA and USN transport fleets. The USN proposed taking over the USA's fleet. The proposal was rejected when the USN was unable to provide trained crews to man USA ships.⁵

On 5 January 1949, the Joint Chiefs of Staff (JCS) studied the feasibility of making the USN solely responsible for sea transportation. As a result of this study, the Military Sea Transportation Services (MSTS) was established on 2 August 1949 and the assets of both the USA and USN were combined.⁶

In the civil sector, reorganization efforts associated with the birth of MSTS were in progress. The Maritime Commission was abolished and replaced by two agencies: the Federal Maritime Board which was responsible for the regulation and administration of the subsidy programs; and the Maritime Administration (MARAD) which was charged with the responsibility of administering the maritime promotional programs.⁷

At the outbreak of the Korean War, the primary civil maritime agencies were only three months old and ill-prepared to initiate effective actions. Defense transportation capabilities were, once again, inadequate.⁸ MSTS was the only organization that had the capability and authority to meet the emergency shipping needs of the Korean War.

Augmenting a nucleus fleet of 174 ships, MSTS acquired over 400 chartered and government-owned reserve ships and with excellent support from private ship operators, began the movement of war supplies and personnel to the combat zone. The initial effort on the part of the newly chartered MSTS clearly demonstrated its capability for innovative action and dedicated service.⁹

Despite MSTS' notable performance, the nation as a whole was not prepared to supply the necessary sealift required to transport logistical supplies to Korea.

Reaction to the lack of sealift preparedness was convincing. The National Shipbuilding Authority (NSA) rapidly assumed its function as a wartime shipping contract agency. NSA was a subordinate shipbuilding agency of MARAD and was established by the Defense Production Act of 1950.¹⁰

MSTS maintained a flow of military supplies to the Far East of over 30,000 tons per day. This task was accomplished by a MSTS-controlled fleet that by 1 April 1953, had grown to 531 vessels, 111 of which had been obtained through NSA general agency contracts. The American flag cargo fleet, which in June 1950 consisted of 633 ships, had by December 1951 swelled to 1,193 vessels, contributing a capability of over 1,000,000 tons per month.¹¹

At the height of the Korean War, MSTS controlled 602 ships and crafts, 335 of them were chartered commercial vessels. In all, MSTS lifted more than 54 million measurement tons

(40 cubic feet to a ton) of cargo, five million troops and passengers, and 22 million long tons of petroleum products to, from, and within the Far East.¹²

In the mid-1960's when then President Lyndon B. Johnson made the decision to intervene in Vietnam, 100 ships of the merchant marine were standing idle on the East Coast and Gulf of Mexico ports due to labor strikes. The maritime union agreed to man ships with the limitation that they would only carry military cargo. As a consequence, the merchant marine responded reasonably well at the outset of the Vietnam conflict. However, it became immediately apparent that the merchant marine was not going to be able to keep up with the escalating demands of the military in Vietnam. One hundred seventy-two mothballed* ships were activated from the National Defense Reserve Fleet (NDRF). This brought the total MSTs-controlled ship inventory to 501 ships. This was sufficient to satisfy the Vietnam requirement.¹³

Between 1965 and 1972, MSTs-controlled tankers delivered more than 16 million long tons (128 million barrels) of petroleum products to Southeast Asia. Government-owned commercial ships under contract with MSTs delivered more than 85 million measurement tons of dry cargo to that area.¹⁴ During MSTs' involvement in Vietnam, 96 percent of the military cargo was moved by sea.¹⁵ This demonstrates the

* See glossary of terms.

importance of the merchant marine in support of a military contingency action.

It can be concluded from this section that at the start of each war, the merchant marine was not fully prepared to meet defense transportation needs. Commencing with World War I, there has been a requirement for a rapid buildup of ships to meet military logistical requirements.

C. GOVERNMENT MARITIME SUPPORT PROGRAMS

The previous discussion on the development of the U.S. maritime industry shows that the U.S. has had to rely heavily on the merchant marine in time of war. In order to improve the merchant fleet's capability to respond in time of national emergency, there have been several maritime support programs initiated by the U.S. government.

1. Shipping Act of 1916

This Act was passed when the U.S. found itself with inadequate shipping assets to meet its military and commercial requirements in World War I. It also established a panel named the Shipping Board for the purpose of creating a naval auxiliary, a naval reserve and a merchant marine to meet the war-time requirements of the U.S. Two thousand, three hundred ships were built to meet the requirements of World War I; however, the majority of them were not delivered until after the Armistice.¹⁶

2. Merchant Marine Act of 1920

This Act, in a clear statement of purpose, related the merchant marine to national defense. It states:

It is necessary for the national defense and for the proper growth of its foreign and domestic commerce that the United States have a merchant marine of the best-equipped and most suitable types of vessels sufficient to carry the greater part of its commerce and serve as a naval and military auxiliary in time of war and/or national emergency, ultimately to be owned and operated privately by citizens of the United States.¹⁷

Toward the end of the decade, U.S. flag shipping was experiencing difficulty in foreign trade. The ships built out of necessity of World War I were nearing obsolescence. Further, the U.S. merchant fleet was experiencing greater operating costs than its competing foreign carriers.¹⁸

3. Merchant Marine Act of 1928

In an effort to provide relief to the U.S. flag merchant fleet, the Merchant Marine Act of 1928 was established. This Act authorized the Postmaster General to contract with the merchant marine for the transportation of mail. This in effect was a subsidy program designed to appease congressional critics. It also provided a 250 million dollar construction loan fund. This fund was used to build 31 new ships and recondition 41 others.¹⁹

4. Merchant Marine Act of 1936

The Merchant Marine Act of 1936, already discussed in the section on sealift development, enhanced the national policy regarding the role of the merchant marine as a naval auxiliary. It created the U.S. Maritime Commission which

had the task of promoting and developing U.S. maritime shipping. The Merchant Marine Act of 1936 provided the U.S. Maritime Commission with a variety of means in order to carry out its mission. These included:

- a. construction--differential subsidies
- b. operating--differential subsidies
- c. loan granting powers
- d. purchase credit allowance
- e. powers to restrict sales and use of vessels acquired by the Commission
- f. payment for required national defense features on subsidized ships
- g. low interest construction loans
- h. income tax benefits for shipowners
- i. construction of vessels for private charter
- j. subsidies to offset payment to foreign competitors
- k. guarantee of ship mortgages
- l. training of merchant seamen
- m. authority to prescribe wage and other benefits to merchant seamen
- n. authority to requisition or purchase ships required for national defense needs.²⁰

The 1936 Act forms the basis for governmental support of the U.S. Merchant Marine.

5. Merchant Marine Sales Act of 1946

During the period of 1936 to 1945, the U.S. Maritime Commission built more than 6,000 merchant ships. As a

result the U.S. government, not private enterprise, owned the largest merchant fleet in the world. The Merchant Ship Sales Act of 1946 was passed in an effort to transfer ownership from the government to private citizens. It gave preference to U.S. citizens in purchasing ships from the government. It also provided for the NDRF. One thousand, four hundred, twenty-one ships were put in mothballs for military contingency. This number has steadily declined. In 1977, there were only 143 vessels in the NDRF.²¹

6. "Fifty-Fifty Law" of 1954

In 1954, Congress passed legislation which channeled one half of the government financed cargo into U.S. ships. The purpose of this law was to compensate owners for the high cost of American flag ships and to prevent them from scrapping their ships and going into other fields of enterprise.²² However, non-subsidized carriers who had purchased ships at bargain prices from the war surplus fleet remained in business only until these ships had to be scrapped. Then these carriers went into other fields of enterprise. They did not build any new dry-cargo ships. The proof of the failure of the "Fifty-Fifty Law" of 1954 was presented in 1976 and 1977. Forty percent of the wheat sold to Russia was to be transported by the U.S. dry cargo fleet; however, there were not enough ships under U.S. registry to lift the full American share.²³

7. The Merchant Marine Act of 1970

The 1936 Act did not completely encourage the development of a balanced cargo fleet. The purpose of the Act of

1970 was to correct this deficiency by expanding, modernizing and increasing the efficiency of the merchant fleet.

The Act of 1970 authorized the establishment of a Commission on American Shipbuilding to track the progress of the American shipbuilding program. It relaxed restriction on operating subsidy eligibility and reset the upper limits on maximum construction subsidies. The Act deferred taxes on earnings gained from foreign and domestic trade if the funds were used to establish a capital fund for new ship construction and rehabilitation. The Act tasked the Secretary of Commerce to determine the type of vessels to be built with construction subsidies. The Secretary, through the Maritime Administration, initiated a series of programs to produce ships for all segments of the merchant fleet.²⁴

Due to the 1970 Act, the U.S. merchant fleet has added 66 new ships and 27 reconstructed vessels up through 1979. The percentage of U.S. liner cargo is at the highest point in the past 20 years.²⁵

8. Summary

It can be concluded from the seven maritime support programs enacted since 1916, that the U.S. government has recognized that the nation's economic well-being and national security are closely related to U.S. strength at sea. The programs presented are designed to aid the development and operation of the U.S. Merchant Marine.

D. MILITARY SEALIFT COMMAND (MSC)

In August 1970, MSTS was renamed MSC. Rear Admiral John D. Chase, USN, a past commander of MSC, stated that MSC was a military organization and not only a commercial shipping line. He emphasized MSC's role in contingency planning and

the development and utilization of new sealift concepts, techniques and systems to include the movement of the USMC and their supplies and equipment.²⁶

The MSC is organized worldwide and is suited to take advantage of containerization and other intermodal* aspects. The organization of MSC is shown in figure II-1.

MSC maintains a fleet that consists of two groups of ships: a commercial chartered fleet and a government-owned nucleus fleet. Figure II-2 shows the assets of these two groups as of 3 February 1978.

The size of the controlled fleet is constantly fluctuating. There is a degree of flexibility which is gained by withdrawing ships from the Ready Reserve Force (RRF) and placing them in full operating status (FOS). Also, commercial charters can be added or deleted, contributing to the fluctuating assets of MSC.²⁷

As of the beginning of 1978, approximately one third of MSC's total amount of controlled ships were chartered from commercial sources. Not all of MSC's assets are used for transportation of military supplies. Approximately one half of MSC's nucleus fleet is used for non-transportation purposes, such as support of research and cable repair.²⁸

MSC's primary mission is to provide contingency sealift capability for the Department of Defense (DOD). Other

* See glossary of terms.

responsibilities include worldwide direction of DOD cargoes by sea in peacetime and the operation of DOD vessels used primarily for the non-transportation purposes already discussed.²⁹ MSC is also tasked with manning some underway replenishment ships in direct support of the USN fleet. The crew of these ships is comprised primarily of civilian personnel.

As of November 1979, the 24-ship Naval Fleet Auxiliary Force consisted of 11 oilers, a stores ship, six ocean-going tugs, three fleet ballistic missile resupply ships and three cable ships. Five additional oilers are under construction. In January of 1980, a 12th oiler, the USS Truckee (AO-147), was turned over to the MSC for civilian manning. MSC is operating more than 50 percent of the USN oilers.³⁰

In order to accomplish its peacetime mission of delivering dry cargo and fuel for the military service, MSC is supported by a 5,700-man work force and a total of more than 105 ships. Ninety-five percent of all the dry cargo that MSC moves is done so in privately-owned ships.³¹

MSC negotiates rates with private carriers for container and breakbulk service. Currently 77 percent of defense ocean dry cargo is shipped by containers. The rest of the cargo is either too large or not suited for containers.³²

The MSC is largely dependent on the U.S. Merchant Marine for movement of military sealift cargo, both in peacetime and in war. Therefore, a viable MSC-controlled fleet is

needed for immediate reaction in military contingency operations. Currently, however, MSC consists largely of aging breakbulk ships and is deficient in the newer intermodal ships.³³

It can be concluded that this shortcoming prevents MSC from satisfying its critical sealift responsibilities. MSC's ability to rapidly react to a military contingency with the right type of ships is in serious doubt.³⁴

E. NDRF

The NDRF is a mothball fleet that comes under the responsibility of MARAD. The NDRF contains approximately 150 "military useful" ships and many of them are left over from World War II.³⁵ Ships in the NDRF are to be maintained in such a manner that they can be activated within 30 days of callup.³⁶

There are numerous problem areas relating to the response capability of ships in the NDRF. The most serious of these is their material condition. The ships of the NDRF are not maintained in a condition conducive to either rapid or economical reactivation. Lack of proper equipment, facilities, and personnel; lack of adequate funding; and lack of an adequate preservation program are all contributing factors to the poor material condition of the reserve fleet.³⁷ It is estimated that an average of 40,000 man-hours per ship will be required to fully service a reserve ship and make it ready for sea.³⁸

Within the NDRF there are 14 ships known as the RRF.³⁹ This is an increase of six ships from 1978. Funding to

upgrade the ships in the NDRF is planned through fiscal year (FY 1982).⁴⁰ These ships are maintained in a state of readiness that would allow them to be put into operation in approximately five to ten days.⁴¹

In early 1976, MARAD conducted an analysis of the time to activate ships from the RRF. The result of MARAD's examination determined that these ships could not be activated within five to ten days. MARAD found that it would take 30 to 40 days to activate them. Since 1976, the ability of the RRF to respond to an emergency callup has not been adequately tested.⁴²

It can be concluded that the ability of the NDRF and RRF to provide reserve shipping within prescribed time frames is inadequate. DOD would have to rely on MSC and privately-owned merchant ships at the onset of a military contingency.

F. EFFECTIVE UNITED STATES CONTROL FLEET (EUSC)

In order to take advantage of liberal corporate laws and tax advantages, many corporations operate a number of ships under Liberian, Panamanian or Honduran registry.⁴³ This commenced in the 1920's and was the beginning of EUSC.⁴⁴ As of February 1977, the EUSC consisted of over 400 vessels.⁴⁵

The use of the fleet for defense purposes and the use of the term "effective U.S. control fleet" came about as a result of a program of Panamanian registry that was an attempt to circumvent the provisions of the Neutrality Act of 1939 and allow the United States to provide essential material to European allies.⁴⁶

DOD accepted EUSC as a viable part of the U.S. defense contingency planning based on the following rationale:

1. contracts in effect between MARAD and affected ship-owners include callup procedures.
2. the laws of Honduras, Panama and Liberia contain no restrictions.
3. the precedent of World War II when Honduran and Panamanian registered vessels were fully assimilated in the U.S. war effort.
4. EUSC shipowners purchased war risk insurance which indicated their intent to serve when called.⁴⁷

A close look at EUSC for use in a military contingency raises serious doubts about its usefulness. Over 300 of the estimated 400 ships in EUSC are tankers that are unsuitable for dry cargo carrying and many of them require deep water ports. Eight-five of the approximately 100 dry cargo carriers are breakbulk ships not suitable for containers. Of the few new modern commercial ships that are in EUSC, most of them are not self-sustaining, i.e., they require sophisticated cargo-handling, support facilities ashore which, during wartime would, in all likelihood, not be available.⁴⁸

Probably the most serious question concerning EUSC would be its responsiveness to national security requirements. Experience during the Vietnam War supports the contention that reliance on EUSC could be a mistake. There were two incidents in the Vietnam War that are worthy of note.

They involved the refusal of foreign crews to sail into a combat zone.⁴⁹

It can be concluded that EUSC cannot be counted upon as a source of dry cargo vessels in time of emergency. The number of vessels of the right type is severely limited. Further, there is always doubt about the reliability of foreign crews to support a U.S. combat effort.

G. POTENTIAL FOR FOREIGN OWNERSHIP IN U.S. MARITIME INDUSTRY

Today there exists a trend toward foreign ownership in the U.S. shipbuilding industry. There has been increasing investment by foreign industrial firms in U.S. plants and companies. This has come about because of the weakening dollar and the high interest rates in the U.S. Ernest G. Frankel, in his article, "The Potential for Foreign Ownership in the U.S. Maritime Industry," states that the impact of foreign ownership will be felt by the U.S. maritime industry in the years to come.⁵⁰ He predicts that there will be no significant difference in the costs of U.S. shipbuilding labor and the material costs experienced by other industrialized countries. The declining dollar and the excess of foreign investment capital could lead to the purchase of major U.S. shipyards or the construction of U.S. ships by foreign interests.⁵¹ Further, foreign owners would not have the same restrictions now placed on U.S. flag operations. For example, U.S. flag operators have to employ U.S. nationals, a restriction that would not be faced by foreign owners. The

fact that the U.S. continues to dominate world trade offers future incentives for investment in U.S. flag shipping.⁵²

Several Japanese and German companies have shown interest in investing in the U.S. shipbuilding industry. One more incentive besides current economic conditions is the potential for increased productivity by foreign shipowners. Potential foreign owners with more extensive experience in the use of technological change in shipbuilding are of the opinion that a great opportunity for major productivity improvements exist in U.S. shipbuilding. Further, they have the opportunity to add the U.S. to their list of traditional markets.⁵³

Foreign investment and ownership in the U.S. maritime industry offers some advantages for the U.S. These include influx of needed capital, infusion of new management techniques, more extensive trading and marketing routes and increasing the scale of operation.⁵⁴

Foreign ownership in the U.S. maritime industry raises some serious questions about its potential as a military auxiliary.

U.S. maritime policy has been based on the traditional premise of defense and economic essentiality for more than 50 years. The assumption inherent in the policy has also been that the U.S. maritime industry should be largely U.S. citizen-owned and manned to assure its reliability under conditions of national emergency.⁵⁵

Can foreign-owned/managed shipyards and vessels be counted on by the U.S. government in time of emergency? As experienced in the Vietnam sealift, it could prove to be a problem.

H. CURRENT TREND OF THE MERCHANT MARINE

There has been a technological revolution that has swept through the world's maritime transportation industry since 1956. The technique of the shipping business has been radically changed. The breakbulk carrier is a ship that carries a cargo of thousands of individual boxes, bags, bales and barrels. It took days of arduous labor by large numbers of men to unload and load a breakbulk ship in the 1950's. In 1956, this concept changed. Malcom P. McLean, a former truck-line executive, proved that it was feasible to stow cargo aboard a ship in containers. Further, this same container could be used to transport items on trucks and railroad cars.⁵⁵ Because of this revolutionary idea, the ship's unloading time was reduced from a matter of days to a matter of hours. Automation, in the form of innovative material handling equipment, took the place of hundreds of longshoremen who manhandled the thousands of packages stowed on the breakbulk carriers.

Speed became the essential feature of modern merchant ship operations. The older breakbulk ships, which travelled at a slow 14 to 17 knots, were far surpassed by the new container-ships.⁵⁶ These new container-carrying ships are designed to travel routinely at speeds that are attained only by express passenger liners. One modern containership can carry as much cargo in one year as five of the old breakbulk carriers.⁵⁷

Aside from containerships, there have been other vessels with different configurations developed in the trend away

from the breakbulk carrier. Of particular interest to the military are the bargeships and the roll-on/roll-off (Ro/Ro) ships.⁵⁸ Each offers cost and service advantages over the breakbulk carrier. They have more speed and can discharge cargo at a faster rate than the conventional breakbulk carrier. The functional characteristics of containerships, bargeships and Ro/Ro ships will be described in detail in Chapter III of this study.

Figure II-3 illustrates the trend away from the breakbulk carrier and toward the containership, Ro/Ro ship and barge-ships.

The specialization of the modern container, barge and Ro/Ro ships present special problems when considering their use in a military contingency. The most significant, particularly in the case of the containership and Ro/Ro ship, is their dependence on unloading equipment located at a pier facility. This problem will be addressed in detail in Chapter IV of this study.

It can be concluded that the increased speed and cargo capacity of the ships found in today's transportation industry are encouraging aspects when considering their use in a military contingency action. However, discharging their cargo without the use of an equipment intensive pier facility poses a significant problem for the military.

I. MERCHANT MARINE AS VIABLE SUPPLEMENT TO THE NAVY

Admiral Elmo R. Zumwalt, Jr., USN, retired, and former Chief of Naval Operations, had urged the USN to turn to the

merchant marine for logistic support.⁵⁹ He advocated using the merchant marine in order to save money on the construction of logistic support ships. He argues that this money could in turn be used for the construction of new warships that the USN needs.⁶⁰

Early in 1979, the General Accounting Office (GAO), in a study made for the House Appropriations Committee, issued a report which said that the USN could save a substantial amount of money by relying more on the merchant marine for logistic support. The study says:

We believe that U.S. merchant ships are a viable supplement to strict reliance on Navy support ships, because the Navy anticipates using commercial assets during wartime (and) commercial ships are reliable, less costly to maintain, and can perform support missions effectively.⁶¹

According to GAO, the USN's own studies show that USN-support ships are more expensive than merchant-marine ships. USN-support ships operate less than their merchant-marine counterparts, but they cost more to maintain.⁶²

The report to the House Committee included these findings:

Navy ships are at sea about 20% of the time, while commercial vessels are at sea 40-70%. The Navy's maintenance costs per ship average about \$2 million a year, compared to \$400,000 a year for a commercial ship. Generally, Navy maintenance costs for amphibious and auxiliary ships and equipment greatly exceed the costs of maintaining equally sized commercial tankers and cargo ships, even though the Navy ships operate much less often.⁶³

However, the current USN attitude toward the merchant marine is not enthusiastic. Causes for this attitude are

the lack of:

1. sufficient compartmentation
2. armament
3. redundance of essential components, equipment and systems
4. ability to maintain a 20-knot speed
5. necessary communications equipment
6. the crew's ability to conduct operations requiring security clearances.⁶⁴

It can be concluded that a merchant ship can be more economically operated than a similar USN support ship; however, there are several deficiencies characteristic of merchant ships when considering their use in a combat environment.

J. CURRENT PROBLEMS OF THE MERCHANT MARINE

On 1 August 1979, the privately-owned merchant marine had 531 ships available. Two hundred forty-five of these vessels were assigned to regularly scheduled dry cargo runs. The age of 62 of the dry cargo liners exceeded 25 years.⁶⁵

Not all of the 531 ships can be considered potential military auxiliaries. The enormous size of some of the newer ships make them completely dependent upon port facilities for both loading and discharging of cargo. Their need for channels 40 feet in depth seriously limit the number of harbors they can enter. Another intangible reason, but of vast importance to the total life of the nation, relates to

the U.S. dependence on raw materials for many of its manufactured goods including munitions. It is mandatory that the transportation essential to the continued operation of the U.S. economy be available without interruption. The possibility of having to decide whether to use the merchant marine to satisfy the demand of industry or to support the military could very well be a possibility in a time of national emergency.⁶⁶

President Eisenhower called the merchant marine the country's "Fourth Arm of Defense."⁶⁷ According to recent testimony before the House Merchant Marine and Fisheries Committee, the "Fourth Arm of Defense" is deteriorating. As of May 1979, there were only 260 U.S. flag ships serving in foreign commerce. It is estimated that almost all of them would be needed for just the first few convoys sent to resupply the countries of the North Atlantic Treaty Organization (NATO) in the event of a war with the Soviet Union and its Warsaw Pact allies.⁶⁸

At the outset of World War II, U.S. yards were building 200 merchant ships a year. In comparison, as of May 1979, there are only 54 ships on order in U.S. yards.⁶⁹

U.S. flag ships are currently carrying only 4.6 percent of America's foreign commerce. Part of the problem has been rate cutting by Soviet shipping companies.⁷⁰

State Department aids now say that Panama under Omar Torrijos will boost Panama Canal tolls 50 percent. This

will have an adverse effect on U.S. commercial shipping interests.⁷¹

The scarcity of orders for both merchant marine and Navy shipbuilding could result in the loss of some 45,000 to 50,000 skilled shipyard workers over the next five years.⁷²

The FY80-construction subsidy for MARAD is 101 million dollars, a reduction of 50 million dollars from FY79's program. This will provide subsidies for only four ships: one barge carrier and three containerships.⁷³ Vice Admiral C.R. Bryan, USN, Commander, Naval Sea Systems Command, testifying before the House Sea Power Subcommittee, said that the declining shipbuilding activity may force shipyards out of business because of the lack of work.⁷⁴

Admiral Isaac C. Kidd, Jr., USN, then the Commander in Chief, Atlantic, and Supreme Allied Commander, Atlantic, when appearing before the House Merchant Marine and Fisheries Committee in 1980, said that NATO would need up to 6,000 merchant ships of 1,600-ton capacity or more in the event of war in Europe. A European war, Admiral Kidd projects, could require the delivery of 1.5 million men and their supplies from North America.⁷⁵

Admiral Kidd points out the serious problem that 25 percent of NATO's ships are "flag of convenience ships," i.e., the ships' companies are international in character and not passport-carrying members of any NATO country. Their loyalty in time of crisis is questionable.⁷⁶

Peter Kyros, special counsel to the House Merchant Marine and Fisheries Committee, states that he is not certain that the U.S. has enough ships to support combat forces overseas in any contingency. He points out that less than five percent of critical imports come in U.S. flag ships. In a major conflict, the U.S. does not have enough merchant ships to support our fighting personnel overseas or to import critical materials to keep our war industries functioning.⁷⁷

According to Kyros, the Soviet Union outnumbered the U.S. by a ratio of 4:1 in ocean-going-merchant and USN ships. Thus in a national emergency, Soviet-merchant and Navy ships would significantly outnumber their U.S. counterparts.⁷⁸

Kyros concludes that the U.S. does not have enough merchant ships to support a large military organization such as a Marine amphibious force (MAF) in time of emergency. Furthermore, not only is the number of ships insufficient but the availability of the appropriate type ship is also absent.⁷⁹

Rear Admiral Bruce Keener II, USN, Commander of MSC, in a testimony before the Senate Subcommittee early in 1980, cited several points related to U.S. sealift. Due to the increasing specialization of merchant ships, there continues to be a downward trend in the size of the seagoing work force. This is a major concern in military contingency since ships without trained crews would be of little or no value.⁸⁰

Fewer ships reduce the flexibility we have enjoyed in the nearly four decades since World War II. Their specialization makes them less effective for

the over-the-beach type operations we can anticipate. Their size magnifies the impact of any loss of ships or cargo--and we can expect heavy losses in the initial phases of any future emergency involving superpowers.⁸¹

Admiral Keener points out that the USN's immediate response force in a contingency consists of the USN fleet and MSC assets. The latter include six specialized and government-owned dry cargo ships, 22 chartered dry cargo ships, 21 tankers in the nucleus fleet and another eight privately-owned tankers under charter to MSC. Of the 150 ships in the NDRF, many are left over from World War II and due to their age and deteriorated condition are not a reliable source of shipping.⁸² Admiral Keener also expressed grave concern as to MSC's ability to man the 14 ships now in the RRF. These ships are supposed to be in a state of readiness that would allow them to be put into operation in five to ten days.⁸³ Whether or not this can actually be accomplished has not been determined.

Colonel Lane C. Kendall, USMCR, former Commercial Shipping Advisor to the Commander of MSC, points out that in the past, military services have made their plans based on the knowledge that merchant shipping would be provided from one of three sources:

1. the liner fleet which would offer the newest, most efficient vessels;

2. the tramp* segment which would make available obsolete but still useful tonnage;

3. NDRF maintained by MARAD for emergency requirements and capable of reactivation in 30 days.⁸⁴

Colonel Kendall goes on to point out that the liner fleet is committed to container systems and is no longer a dependable resource for movement of breakbulk cargo. The tramp segment disappeared as its World War II ships became obsolete. NDRF contains only a score or two of usable ships, the once large number having been reduced due to age and advanced technology.⁸⁵

It can be concluded from this section that the availability of U.S. merchant ships to support a military contingency action is severely limited. In time of war, U.S. government decision makers would have difficulty in determining whether to use merchant ships to keep a steady flow of imported raw materials necessary for the production of war goods or to use them in direct support of combat operations.

There has been a significant reduction in U.S. shipbuilding; therefore, the number of U.S. merchant ships is expected to continue to decline. This may force many shipyards out of business and could have serious effects when trying to increase production in time of war.

* See glossary of terms.

K. SUMMARY

A brief history of the merchant marine in a military contingency has been presented. It was determined that in each war, commencing with World War I, the merchant marine was not adequately prepared to meet military transportation requirements. In response to this problem, U.S. maritime support programs have been established. However, they have not been completely effective. Some of the sealift problems that the U.S. government has faced in past wars are existent today. In terms of availability, there is a lack of a sufficient number of U.S. merchant ships to support a major conflict.

In addition, there are some new problems. U.S. shipbuilding is on the decline. Ships that are being built are specialized and their use by the military is severely constrained by the requirement for deep water, equipment-intensive pier facilities. There is some speculation that shipbuilding activities will transfer to foreign ownership. This raises the question of the foreign owners' eagerness or ability to respond to U.S. shipbuilding demands in time of war.

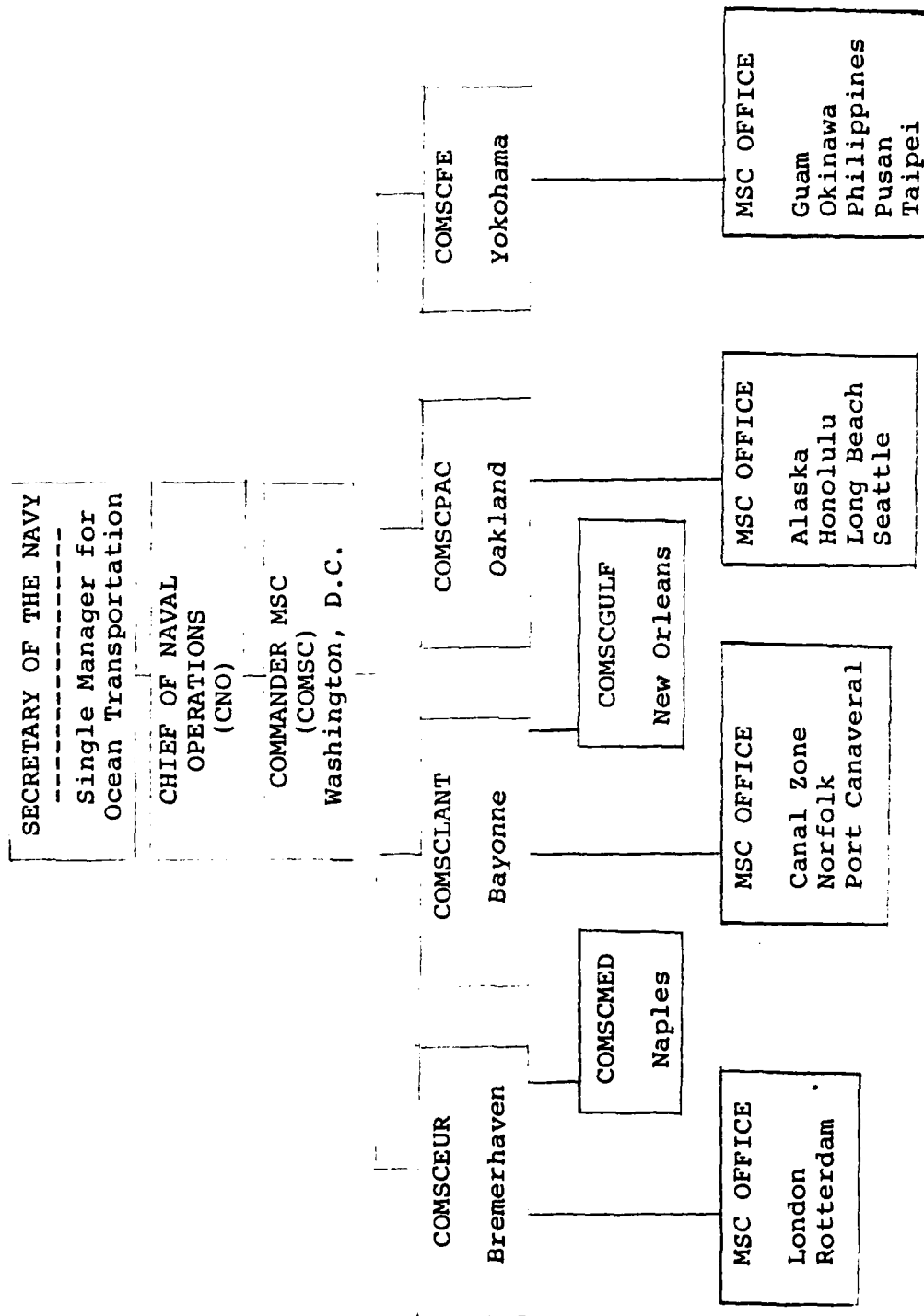


Figure II-1. Sealift Command Organization

Source: Cook, p. 52

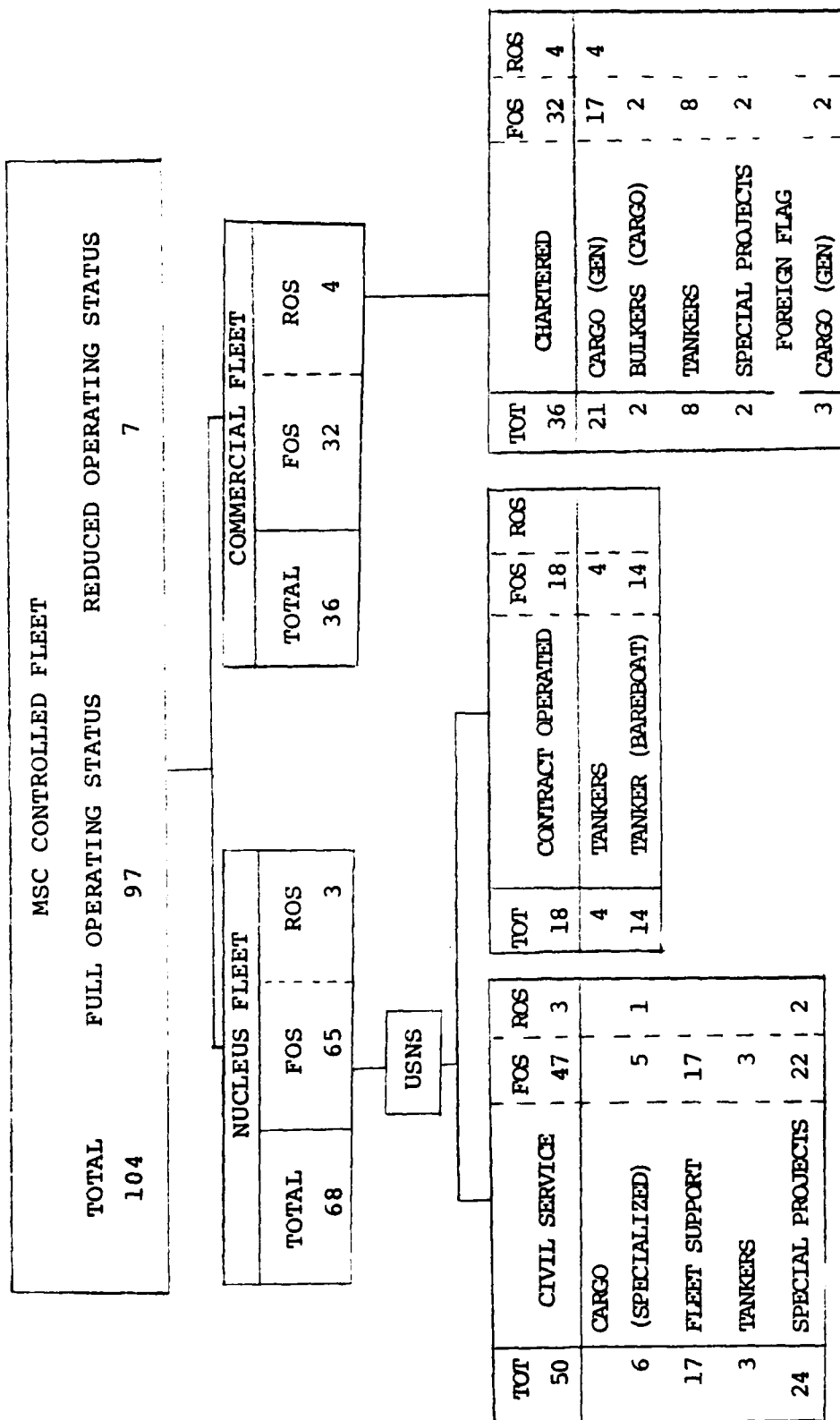


Figure II-2. Military Sealift Command Controlled Fleet

Source: Cook, p. 55.

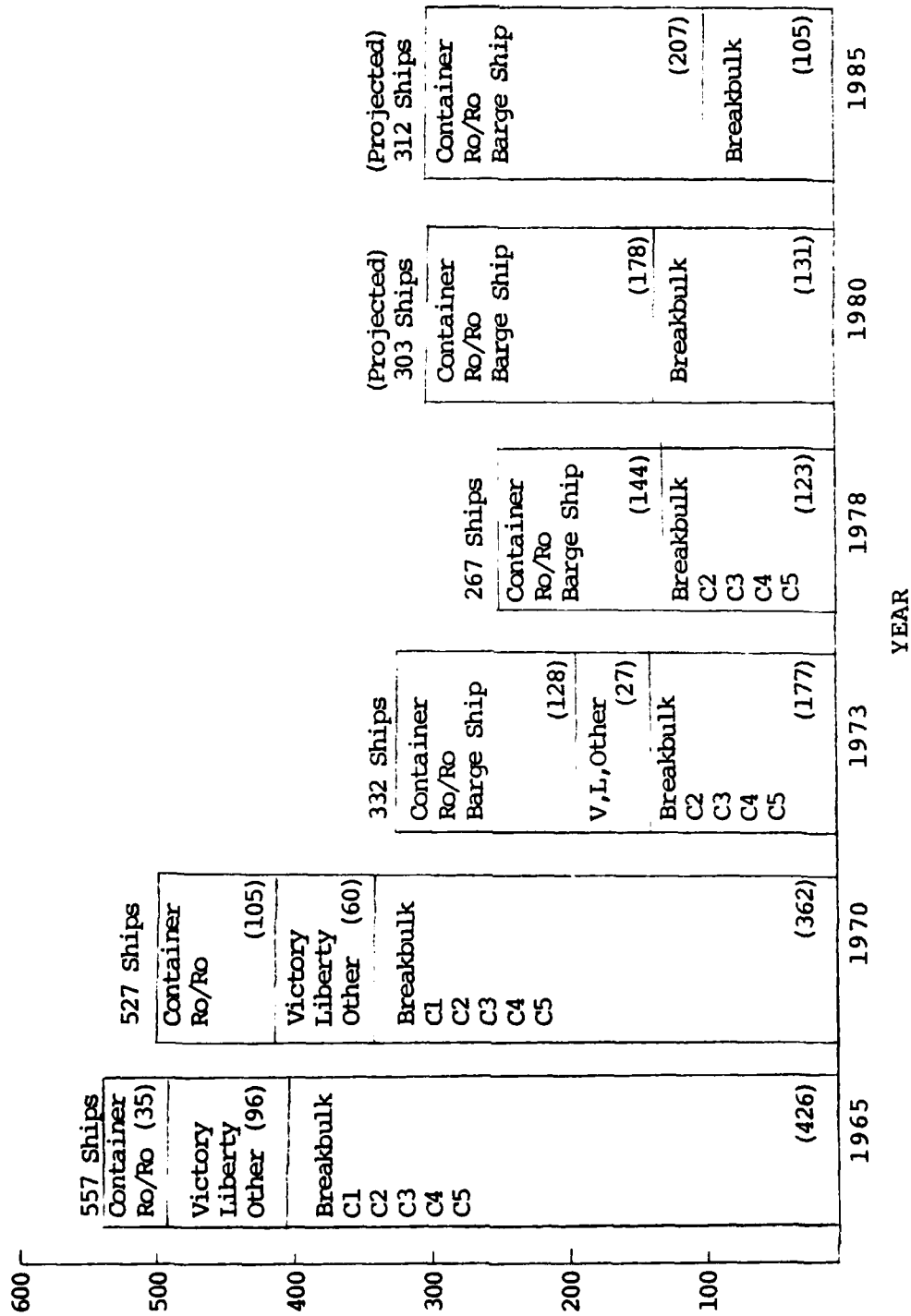


Figure II-3. The Trend in Composition of U.S. Privately-Owned General Cargo Fleet

Source: Cook, p. 18

III. FUNCTIONAL CHARACTERISTICS OF MERCHANT SHIPS

A. INTRODUCTION

Chapter II pointed out that the United States (U.S.) has continually relied on the use of merchant ships in past wars. The source of merchant ships and their availability to support the military are aspects that were also discussed in detail. This chapter will analyze the functional characteristics of merchant ships and their suitability to perform specialized tasks in support of a USN/USMC amphibious operation. Before this analysis is undertaken, a general comparison will be made of dry cargo carrying merchant ships and USN amphibious ships. Despite the trend toward containerization and container-carrying ships, breakbulk (general purpose cargo) ships are still available in the U.S. flag merchant fleet and the Military Sealift Command (MSC). Therefore, an analysis of the functional capabilities of the breakbulk ship for use in an amphibious operation will be included.

The ships analyzed are projected to be in existence at least through the year 1984.¹ The five categories of ships that will be discussed are listed below:

1. passenger/cargo ships
2. breakbulk ships
3. roll-on/roll-off (Ro/Ro) ships
4. containerships:
 - a. self-sustaining
 - b. non-self-sustaining

5. bargeships:

- a. lighter aboard ship (LASH)
- b. Seabee
- c. Trimariner

In evaluating their functional characteristics and suitability, two basic roles for the merchant ships in an amphibious operation are considered:

1. as a ship of the assault echelon (AE)

A ship utilized in this echelon would be required to deliver those most critical assault elements needed to seize a beach head and rapidly build up combat power ashore. The AE is comprised primarily of combat (e.g., infantry) and combat support units (e.g., artillery). Generally, the AE consists of all assault troops, vehicles, aircraft, equipment and supplies required to conduct the assault landing.²

2. as a ship of the assault follow-on echelon (AFOE)

A ship utilized in this echelon would be required to deliver those remaining elements needed to sustain the initial assault. The AFOE consists of combat service support units (e.g., maintenance, engineer and supply) and would normally be embarked in a mix of USN amphibious ships and merchant ships. However, with the reduced amphibious shipping assets of the USN, it is more reasonable to assume that in a Marine amphibious force (MAF)-size operation, the AFOE would be embarked almost entirely in merchant ships. The AFOE will normally commence landing on D* + 5.³ The requirement

* See glossary of terms.

to have shipping in the amphibious objective area (AOA), approximately five days after the landing, precludes the use of AE shipping to transport the units and supplies of the AFOE.

Ships used in both echelons must be capable of offloading in a hostile environment and in the open sea. This can pose a problem of great magnitude when considering that merchant ships are designed for loading and offloading at a pier facility located in a sheltered harbor.⁴ In evaluating the merchant ships for use in the AE and AFOE, the assumption is made that the amphibious task force (ATF) will face a greater degree of enemy hostility in the AE. This assumption is based on the following:

1. the AE includes the initial unloading of the landing force and its equipment; it is tactical in character; any enemy resistance in the AOA will, in all likelihood, be encountered by the AE of the ATF.

2. the AFOE is logistical in character; the commander of the amphibious task force (CATF) will not order the AFOE in until the AOA has been determined to be secure; the possibility of enemy resistance during the AFOE has been significantly reduced. Emphasis in the AFOE is on speed and volume of unloading operations.⁵

B. DIFFERENCES BETWEEN COMMERCIAL SHIPS AND USN AMPHIBIOUS SHIPS

1. Background

The primary objective of the dry cargo merchant ship is to deliver a high volume of cargo as fast as possible

with little or no damage. Meeting this objective enhances the prospect of profit maximization. The merchant ship captain is concerned, first, with the safety of the ship; second, with the safety of the cargo; and third, with the expeditious delivery of cargo. If a merchant ship developed mechanical trouble that would cause extensive damage to the ship with continued operation, the captain would cease operation and commence corrective maintenance. This would, in effect, sacrifice the expeditious delivery of the cargo for the safety of the ship.⁶ The captain of a USN amphibious ship would not have the same priorities. If he were involved in an amphibious operation under hostile conditions, expeditious delivery of the men, equipment and supplies of the landing force is of paramount importance to the success of the operation. The ship's captain would, in all likelihood, risk extensive damage to the ship in order to meet this objective.⁷

The difference in objectives of the USN amphibious ship and the dry cargo merchant ship results in significant differences in design, manning and on board equipment. As will be pointed out in a later section, these differences are important considerations when evaluating the use of merchant ships in an amphibious operation.

2. Manning

To illustrate the large difference in personnel, the USN amphibious cargo ship (LKA)-117, requires 330 personnel to operate under tactical conditions. Whereas in normal

point to point operations, a typical merchant general purpose cargo ship, such as the SS American Challenger, requires only 40 personnel.⁸ Table III-1 is a comparison of the manning requirements for both ships.

The USN amphibious ship must maintain personnel at all stations essential for the operation and defense of the ship. Operational or defense demands may require the ship to get underway immediately. Therefore, the bridge, the signal bridge, the combat operations center, the communications and engineering stations all have to be fully manned. Also the debarkation control center, the surface and air debark stations, the cargo holds, the ship's boats, the emergency boat repair station, the repair party stations and the weapons must be manned to the greatest extent possible. An LKA has approximately 100 men allotted to the ship to handle cargo.⁹

Commercial ships on the other hand depend on manpower resources located at the port facilities for the loading and unloading of cargo. The crew of the merchant ship provides the necessary manpower to operate the ship from one point to the next and the necessary personnel to support requirements such as the manning of the galley and the ship's store.¹⁰

3. Communications

The USN amphibious ship must be capable of sailing in formation with other ships of the task force. Continuous

communication, particularly in severe weather conditions, is a must. In addition, the amphibious ships must be equipped with the capability of communicating with the landing force once ashore. The extensive communication network requires space for operators and maintenance personnel. The ship must also be configured with ample room to accommodate the communications equipment.¹¹

The commercial ship does not have a sophisticated network of communications. It is not designed to carry a landing force. A network designed for communication in a tactical situation is not necessary for normal day to day operations. The commercial ship does not have to maneuver in formation, at various speeds and under severe conditions. Therefore, the communication network on a commercial ship is relatively simple compared to a USN amphibious ship. To illustrate, Sealand Inc., the world's largest privately-owned container shipper, has a total of 60 ships which call at 122 ports in 46 countries. Sealand Inc. puts communication relatively low on the priority list. This is typical of other containership operators. Sealand Inc. vessels are very rarely at sea more than seven days and are usually at a major port every two weeks. Apart from emergencies, crew illnesses and injuries, there is little need for ship-to-shore contact. Only twice in a ten-year period did one ship manager in a container shipping company have to contact ships to order a change of course. Sealand Inc.'s policy toward communications is to keep it simple and reliable.¹²

Systems on the USN ship are designed to provide redundancy for increased survivability. The propulsion system is of main concern. Speed and maneuverability are extremely important in a combat situation. Therefore the manning level of engineering departments of the USN amphibious ship is significantly increased over that of a commercial ship.¹³

5. Ship Design Consideration

A major design difference between amphibious ships and commercial ships relates to the delivery of landing force personnel and equipment to shore. Helicopter operations, wet-wells for efficient operation of preloaded boats and amphibious vehicles and special ramps for the discharge of equipment are all characteristics that distinguish USN amphibious ships from their commercial counterparts.¹⁴

USN ships are designed to survive despite large openings in the hull. For example, an LKA-113 class could survive with two, possibly three, compartments flooded. On the other hand, a commercial cargo ship can survive but one flooded compartment.¹⁵

6. Electronics

USN amphibious ships have radar suites designed for defense and ship control, modern navigation equipment, at least three internal powered telephones, and general selective announcing systems.¹⁶ Whereas, commercial ships have only surface radar and simple navigation suites designed to facilitate economical point-to-point cargo transportation.¹⁷

7. Weaponry

Although USN amphibious ships are not classified as combatant-type ships, they do have weapons for self-defense. A typical close in weapons system (CIWS) consists of 20 mm machine guns, firing 3,000 rounds per minute. The "Gatling gun" as it is called can lock onto a target and shred it within a fraction of a second.¹⁸

Commercial ships do not carry weapons; therefore, it can be concluded that their probability of survival in a military contingency is significantly decreased.

8. Power Supply

A USN ship such as the LKA-113 class, besides its primary power source, has two 500 kilowatt (kw) emergency diesel generators.¹⁹ Therefore, the ship has three separately located sources of power. The lack of vital functions such as main plant auxiliary equipment, steering, communications, weapons and operation of pumps is minimized. Generally, the commercial cargo ship has one emergency diesel-driven generator of sufficient capacity (50-100 kw) to provide limited emergency lighting and to light off the main steam plant without an external source of power.²⁰ The possibility of losing vital functions is a good deal greater in the merchant ship.

9. Fire Control

The USN amphibious ship is designed and manned to control several fires at one time. A typical amphibious ship such as the LKA-113 has smoke detection and fog foam

flooding in the cargo holds. In addition, amphibious ships have a damage control organization, three damage control lockers with equipment for fire and flooding control and three trained control repair parties.²¹

The commercial ship usually has a single fore and aft fire main supplied by two fire pumps located in the engine room. It is usually highly dependent on early detection of a fire and has the ability to extinguish a fire with a finite amount of CO₂ or fog foam.²²

10. Living Accommodations

Due to the significant difference in the personnel capacities of USN cargo ship and commercial cargo ship, there is a large difference in the living accommodations and personnel support spaces. As already pointed out, USN crews are much larger, plus living space must be provided for embarked personnel of the landing force. There are more berthing compartments, messing areas, lounges, heads, showers, galleys, scullerys, incinerators, office spaces, store rooms, shops, air conditioners, refrigerators and water supply in a USN amphibious ship than in a merchant ship. All these factors have an effect on the ship's design and amount of personnel required to man the personnel-support areas. If merchant ships are to be used in an amphibious operation, the billeting for the additional crew and members of the landing force is a major consideration. Figures III-1 through III-9 pictorially summarize the amphibious-ship types used by the USN.

It can be concluded from this section that there are large differences between USN amphibious ships and dry cargo commercial ships. The USN ship is built to accomplish its mission in a hostile environment. In order to do this, survivability of the ship is the prime concern in its design. The commercial dry cargo ship is built for efficient movement of cargo from one point to another as cheaply as possible. Economical considerations are of prime concern in the design of the merchant ship. The differences in the two ships have to be considered when planning shipping requirements for a USN/USMC amphibious operation. The probability of survival in a hostile environment for a merchant ship in its present configuration is a great deal less than a USN amphibious ship.

C. SUITABILITY OF MERCHANT SHIPS FOR AMPHIBIOUS OPERATIONS

1. Introduction

This section provides a more detailed analysis of the suitability of each type of merchant ship to function in an amphibious operation. Each ship type will be analyzed for its suitability in the AE with and without major modifications. Further, it will be analyzed for its suitability in the AFOE without major modification. The type of merchant ships discussed are those listed in the introduction to this chapter.

2. Background

a. Merchant Ship in the AE

As pointed out in the previous section, merchant ships have crew and working space for about 40 to 45 personnel. Although there is some room for flexibility, an attempt to expand the capacity of a merchant ship to accommodate some 300 USN crewmen is not possible. Major modifications would have to be made and this would result in a significant reduction in the ship's payload. The extent of the modification needed can be estimated by examining the nature of the ship and the type and amount of cargo-handling equipment on board. These facts have to be considered in tailoring the manning level to perform the mission of an amphibious ship. Table III-2 lists appropriate crew estimates for the various types of merchant ships if they were to be used in the AE of an amphibious operation. Depending upon what type of merchant ship is being considered, the required manning level ranges from 250 to 400 personnel.

A merchant ship designed for 40 to 45 civilian crew members has approximately 4000 square feet (sq. ft.) of living space or 90 sq. ft. per man.²³ A USN crew man is allotted 25 sq. ft.²⁴ Therefore, 4000 sq. ft. of living space could possibly be converted to provide living accommodations for 160 crew men. This is far short of the 250 to 400 crew men required to man a ship participating in the AE of an amphibious operation. The additional crew would need from 2250 to 6000 sq. ft. of living space. Assuming the

height of the living space is ten feet (ft.), the additional cubic feet (cu. ft.) requirement could range from 22,500 to 50,000. The average cargo ship has approximately 160,000 cu. ft. of cargo space.²⁵ Therefore, the additional crew would consume from 14 percent to 37 percent of the ship's cargo-carrying volume for living space alone. This does not take into consideration the living accommodations of the additional landing-force personnel and the facilities required to support this additional crew and embarked personnel from the landing force.

Major modifications in the merchant ship would also be required in other areas. One of the more challenging problems in designing an amphibious ship for the USN is to find ways to accommodate the extensive array of communications/electronics (COMM/ELECT) equipment.²⁶ As discussed, the merchant ship is built with only the most basic COMM/ELECT equipment. Major modifications to facilitate this equipment would be necessary prior to participation in the AE of an amphibious operation.

Modification would also have to be made to the damage-control equipment, the emergency-power sources, the fire-fighting equipment, and the defensive weaponry, to name a few.

It can be concluded that commercial ships that normally operate on a narrow profit margin and are designed for a specialized commercial operation could not be modified on a short notice to be used in the AE of an amphibious

operation. The time-consuming and extensive modification would result in considerably less payload capacity. This would render the merchant ship uneconomical for use as a commercial carrier.

b. Merchant Ships in the AFOE

In the AFOE which usually commences at D + 5 as previously pointed out, the enemy threat will have lessened considerably. Consequently, this fact weighs heavily in analyzing the use of commercial ships for service in the AFOE. The problems of ship control, survivability and ship unloading still exist in AFOE; however, these problems are different from that of the AE. AFOE includes shipping used to transport units, supplies and equipment required for the buildup of a beach head and to resupply the landing force.²⁷ Assault follow-on shipping is echeloned into the objective area upon request of the CATF. This will not be done until the objective area is considered secure enough to do so.

In the AFOE, military personnel are now available to offload ships. More sophisticated material handling equipment (e.g., floating cranes, causeways) can be moved in, set up and utilized. Landing craft can move in a more logistical fashion from ship-to-shore. Shipboard-tactical communication, although still necessary, would not have to be as sophisticated. Temporary communications equipment placed aboard merchant ships to cover tactical warning and maneuvering circuits would be sufficient. Survivability characteristics such as weaponry, redundancy in engineering systems,

sophisticated fire-control and pumping systems would not be as important aboard ships in the AFOE as compared to AE ships.

It can be concluded that the criteria set forth for evaluating the use of merchant ships in the AFOE is significantly different than that of the AE.

3. USN's Landing Craft Air Cushion (LCAC)

The USN has recently taken delivery on its first LCAC, the JEFF B, at the Naval Coastal Systems Center in Panama City, Florida. The JEFF B, pictured in figure III-10, has a gross weight of 325,000 pounds (lb.) and has achieved speeds of more than 50 knots (kn.).²⁸ The LCAC has the ability to proceed beyond the water's edge to offload its payload. This flexibility can be translated into tactical surprise, increased survivability and a rapid buildup of forces ashore. The LCAC has been designed to operate from the well decks of amphibious ships. Riding on a cushion of air a few inches (in.) above the surface of water or land, the craft will be able to transition from the sea through the surf and across the beach to discharge its payload on hard ground.²⁹ Because of the feasibility and utility of employing the LCAC by the amphibious forces of the future, it will be evaluated for use with each type of merchant ship addressed in this study.

4. Analysis of Each Merchant-Ship Type for Use in an Amphibious Operation

a. Cargo/Passenger Ship

This ship has four major shortcomings for use in the AE:

- (1) the lack of COMM/ELECT and combat-information-center equipment
- (2) the inability to embark/debark by helicopter, requiring the dangerous use of cargo nets for troop debarkation
- (3) the inability to carry LCAC vehicles
- (4) a severely limited damage-control capability

It can be concluded that the cargo/passenger ship is not suitable for use in the AE.

In order to consider this ship for use, a USN crew of 299 men would be needed for an amphibious assault operation.³⁰ Existing crew accommodations and some cargo space would have to be reconfigured to provide berthing, messing, sanitary facilities, medical spaces and other personnel-support facilities. In addition to the crew accommodations, the following modifications would be required:

- (1) convert 118,000 cu. ft. of cargo space to accommodate 175 additional troops
- (2) install CIWS for self-defense
- (3) install surface-search radar, signal bridge, combat-information center, communication central and an internal-communication system
- (4) install damage-control equipment, pumps and fire-fighting equipment

(5) install an emergency diesel generator

(6) install eight landing crafts such as the LCM-6
pictured in figure III-11

(7) install a helicopter-landing platform with flight
operations and safety equipment.

The cost of these modifications is estimated to be 105 million dollars.³¹ Even with these extensive modifications, the ship would still be inferior to a modern USN amphibious ship in the areas of troop and cargo capacity, debarkation capability and survivability. This is primarily due to the ship's commercial design and standards as opposed to that of the military.

Because of personnel capacity, the combination cargo/passenger ship is useful in the AFOE. The ship's large superstructure and relatively spacious civilian crew and passenger/tourist accommodations could be modified without major rework to accommodate 300 USN crew and the 500 embarked troops of the landing force. If major modifications were to be effected, the ship could handle 1,500 troops.³²

A major benefit of the cargo/passenger ship is the four on-board container gantries. These give the ship the self-sustaining capability to unload containers directly from the ship into a lighter* for ease in ship-to-shore movement.

It can be concluded that the cargo/passenger ship is very useful in the AFOE because of its troop-carrying

* See glossary of terms.

capacity and container-carrying/unloading capabilities. However, due to commercial airlines providing relatively cheap and fast intercontinental transportation, there are presently very few cargo/passenger ships in service. Four ships under American flag are classified as cargo/passenger vessels. The Delta Line's Santa Mercedes class shown in figure III-12 carries 125 passengers as well as provides 447,000 cu. ft. of cargo space. These 21 kn. ships are 547 ft. long, 79 ft. wide and have a 27-foot draft. They were built in 1963 and 1964 and are assigned to Western Hemisphere trade. There are no new cargo/passenger ships planned for construction.³³

b. Breakbulk Ship (General Purpose Cargo Ship)

The breakbulk ship can be examined in relation to the LKA-113 Charleston class amphibious ship pictured in figure III-4. The Charleston class ship is essentially a commercial cargo ship; however, it has all of the equipment and the proper design to operate in a tactical environment.

The merchant-breakbulk ship has a large cargo-carrying capacity and functions well in a commercial environment, steaming alone from one port to another. Cargo is loaded and unloaded with material-handling equipment and longshoremen available in the port facilities. As a ship in the AE of an amphibious operation, it has many of the same problems of the cargo/passenger ship:

- (1) lack of sufficient crew (30 men compared to the required 300 for an amphibious operation)

(2) lack of space (exclusive of cargo holds) for the necessary COMM/ELECT equipment

(3) lack of surface space for helicopter landing (the deck configuration makes landing of a helicopter not feasible)

(4) lack of capability to be replenished at sea.³⁴

Without major modification the breakbulk ship could not be used in the AE of an amphibious operation. In order to make the breakbulk ship a suitable carrier of troops and equipment, the following modifications would have to be accomplished;

(1) convert existing crew accommodations in superstructure to provide USN operational spaces such as a communications center and billeting for ship's officers

(2) convert 300,000 cu. ft. of cargo space on the second deck to accommodate the billeting of a 301-man crew and 300 troops of the landing force (this would include all the support facilities)

(3) install CIWS with magazines and fire-control systems

(4) install surface-search radar, signal bridge, combat-operation center, communication central, crypto room and internal communications

(5) install USN damage-control systems and emergency-pumping system

(6) install one additional ship's service generator

(7) install one additional emergency-diesel generator

(8) install four mechanized landing crafts (LCM)-8

(9) install a helicopter landing platform with associated flight operations and safety facilities.³⁵

The estimated cost to make the above modifications would be 86 million dollars.³⁶

Even with extensive modifications, the converted breakbulk ship would still be inferior to the modern USN amphibious cargo ship in boom size and number, cargo accessibility, cargo capacity, cargo flow to air debark spot and landing-craft capacity. The probability of survivability is lessened because of the design of the commercial ship. It would have limited helicopter-debark capability. It is not capable of transporting the LCAC either before or after modification.³⁷

Many of the characteristics that make the breakbulk ship profitable as a commercial carrier, also make it a useful ship for use in the AFOE. The breakbulk ship has the following advantages:

- (1) it can travel at relatively fast speeds, 20 kn. or better
- (2) it has a large cargo capacity (this would be reduced somewhat by adding tactical features)
- (3) it has self-sustaining capability as a result of an on-deck 70-foot boom.³⁸

Even in the AFOE, the breakbulk ship does have one major limitation. Despite the ship's self-sustained loading and unloading capability, it relies on stevedores* located at the various ports to operate the booms. Therefore in

* See glossary of terms.

an amphibious operation, personnel to operate the booms would have to be added to the crew.

Despite the trend toward containerization, not all cargo can be or will be containerized. There will still be a percentage of the cargo that will be palletized or packaged in some other form. Currently 77 percent of defense ocean dry cargo goes by containers. MSC officials say that may be the maximum since the rest of the cargo is either oversized or not suited for containers.³⁹ It is in the transportation of general purpose cargo that the breakbulk ship fills a very important void. However, as discussed in Chapter II of this study, the growing emphasis in U.S. shipbuilding is on non-self-sustaining containerships. The number of breakbulk carriers is diminishing and present indications are that no U.S. operator plans to buy new ones. Figure III-13 is a picture of a breakbulk ship, the SS American Courier. It is one of the many merchant ships chartered by MSC. It is shown offloading an LCM-8.

c. Modern Ro/Ro Ship

The commercial Ro/Ro ships can be compared to the USN tank landing ship (LST) pictorially displayed in figure III-9. The USN LST is the nearest amphibious counterpart to the commercial Ro/Ro ship. It is primarily designed as a vehicle carrier and can rapidly load and unload its rolling stock at any commercial port with a heavy pier facility.

The LST, on the other hand, is designed and reinforced so that the ship can be deliberately beached and

retracted under normal conditions. The LST is mainly a vehicle carrier. The Newport class LST-1179 has the capability to unload trucks and tanks by a ramp-over-the-bow. The ramp is 110 ft. long, aluminum in construction and has a 75-ton capacity.⁴⁰ The LST also has a stern gate that allows loading and unloading an amphibious vehicle such as the landing vehicle tracked personnel (LVTP7) pictured in figure III-14. The LST can debark the amphibious vehicle in deep water while it is underway.

The Ro/Ro on the other hand falls far short of the amphibious capabilities of the USN LST. The Ro/Ro, like any other commercial ship, cannot be beached without receiving severe or terminal damage. Therefore, unloading has to be accomplished at a pier by use of a ramp. The dry well-deck of a Ro/Ro ship can accommodate a LCAC vehicle; however, launching and retrieving the vehicle would not be feasible since the deck is ten ft. or more above the waterline. Further, the stern openings are less than half of the required size for passage of a LCAC vehicle.

The Ro/Ro ship has all the other limitations that are characteristic of the commercial cargo/passenger ship and breakbulk ship already analyzed. These include:

- (1) shortage of necessary COMM/ELECT equipment and facilities
- (2) limitations in crew and embarked personnel of the landing force
- (3) lack of billeting accommodations for an increased crew and members of the landing force

- (4) inadequate damage-control capabilities
- (5) lack of helicopter-landing pads, requiring troop debarkation by the dangerous use of cargo nets
- (6) lack of underway-replenishment capability.⁴¹

Amphibious vehicles are used for the delivery of troops in the tactical assault. The unmodified Ro/Ro ship does not have the capability to debark these vehicles in deep water. This eliminates a Ro/Ro from consideration for use in the AE. Further, the inability to offload vehicles such as tanks, trucks, jeeps, towed and self-propelled artillery pieces directly to the beach or onto a floating causeway negates the most important attributes of this ship, i.e., its ability to carry military rolling stock.

In order to consider the Ro/Ro for operation in the AE of an amphibious operation, the following modifications would be required:

- (1) existing crew accommodations in the superstructure would have to be converted to provide billeting for the ship's officers.
- (2) approximately 249,600 cu. ft. of vehicle/cargo space would have to be converted to accommodate the 243-man crew and the 300 embarked troops of the landing force.
- (3) one helicopter landing position would have to be installed with operational and safety equipment.
- (4) a CIWS would have to be installed fore and aft for defense of the ship.

(5) damage control, pumps and fire-fighting equipment would have to be installed.

(6) one emergency generator would have to be installed.

(7) two LCM-6's would have to be installed.

The estimated cost of this list of modifications is 82 million dollars.⁴²

But even with the necessary modifications, the Ro/Ro ship still has one major shortcoming that eliminates it from consideration for use in the AE. The amphibious vehicles that would be embarked aboard the Ro/Ro ship are required for use as troop carriers in the assault. In order to debark these vehicles, major ship rework would be required. This would include rebuilding the hull access, the ramps, the ramp support and the surrounding hull structures. Major rework of this nature would be unreasonably expensive and time-consuming.⁴³

The structure of a Ro/Ro vessel is designed specifically for commercial operation with the ship tied up in calm water to a heavy pier. Only the ramp has to be strong enough to act as a short bridge between the ship and the pier. In the AFOE, it is highly unlikely that a heavy commercial pier will be available. Therefore, unloading must be accomplished onto a floating causeway similar to the one pictured in figure III-15. The M-60 tank currently in the USMC's inventory weighs 60 tons. Offloading a vehicle of this size onto a floating causeway would be extremely hazardous in calm flat seas and not feasible in heavy rolling seas.⁴⁴

The Ro/Ro ship, because of its vehicle-carrying capacity, has tremendous potential in the AFOE; however, the cargo offload problem must be solved first.

At present, American-owned Ro/Ro ships that have the potential for use in USN/USMC operations are the United States Navy Ship (USNS) Comet, the USNS Sealift, the Admiral William M. Callaghan, the Defiance class (four ships), the new Maine class (four ships), the Ponce de Leon class (five ships), the Lurline class (two ships) and the Great Land class (three ships).⁴

The USNS Comet, pictured in figure III-16, is the oldest of the Ro/Ro ships. It was put into service by MSC in 1958. The Comet has a stern gate and a total of four side ports. Ramps for the side ports can be handled by the ship's booms and can be stowed on the main deck. Ro/Ro access is provided to all decks by internal ramps.⁴⁶

MSC acquired the Sealift that is pictured in figure III-17 in 1967. It has a stern gate and side port arrangement. Ro/Ro ship access is provided to all decks via ramps.⁴⁷

The Admiral William M. Callaghan pictured in figure III-18 is operated by Sunexport Holdings and is on long term charter to MSC. It is noted for its gas turbine propulsion system. It has the same basic stern and side port arrangement as the Comet and Sealift.⁴⁸

The Defiance class pictured in figure III-19 includes four ships. The first was built in 1969 by

Litton-Ingalls for Moore-McCormack Lines. They are now operated by American Export Lines of New York. These ships are primarily containerships having only one deck available for Ro/Ro cargo. These ships have a stern ramp and one side port each side aft.⁴⁹

The four ships of the Maine type pictured in figure III-20 are built by Bath Iron Works for the States Steamship Company. They are multi-purpose ships capable of handling all types of Ro/Ro cargo. Ramps allow Ro/Ro access to all decks. A large side port is located about the middle of the ship on the starboard side and a smaller side port is located on the port side forward.⁵⁰

The first of the five Ponce de Leon class ships shown in figure III-21 was built in 1968 by Sun Shipbuilding for the Transamerican Trailer Transport Company (TTT). One ship is operated by TTT and the other four by the Puerto Rican Maritime Authority. These ships carry trailers with special tractors and ramps provided by the ports serviced. Loading and unloading is done through three side ports located in the starboard side. No stern gate is provided in the Ponce class.⁵¹

The two ships of the Lurline class, shown in figure III-22, are similar to the Ponce class ships.⁵²

The three ships of the Great Land class Ro/Ro shown in figure III-23 are an extension of the Ponce class ships. The Great Land class differs from the Ponce type in that it has openings in the transcom. Normal operations

would involve loading in the transom and offloading from the main deck to the pier.⁵³

The Baltic Eagle, pictured in figure III-24 and built in Finland for its London owners, is the latest custom-built Ro/Ro vessel. It is ice strengthened for vigorous North Sea and Baltic service and was built to allow for future conversion to permit substantially increased number of passengers. Both of these characteristics enhance its potential for use in a military contingency.⁵⁴

The Ro/Ro method of transferring cargo between ship and shore represents the ultimate in vessel self-sufficiency. Over the past decade, advances in Ro/Ro technology have taken place principally in the fields of access ramps and internal ramping arrangements.⁵⁵ The need for a pier facility for loading and unloading is still the major obstacle for use in the AFOE of an amphibious operation. This problem will be discussed in more detail in Chapter IV.

d. LASH Barge Carrier

The LASH has the capability of carrying barges which speeds the loading and unloading functions. The barges are handled by means of a gantry crane which rolls out beyond the stern of the ship and drops a lifting structure onto the barge. Barges are lifted to deck level, transported forward by the gantry and lowered into one of the holds or stowed on deck. Some LASH configurations also have the capability of carrying containers. In container-carrying

LASH ships, the lifting structure is configured to the containers.

As with the other commercial ships discussed thus far, the LASH ship has many shortcomings when considering its use in the AE of an amphibious operation. These shortcomings include:

- (1) inadequate COMM/ELECT
- (2) inadequate damage-control capabilities
- (3) inadequate crew and troop accommodations.⁵⁶

In addition, there are limitations that are unique to the LASH barge carrier. There is total dependence on a single barge gantry for loading and unloading. Mechanical failure of the gantry would result in no alternative means to unload cargo. The gantry-cycle time (time to unload one barge is 15 minues)⁵⁷ is too slow under the combat conditions of the AE. Another consideration is the seastate. Current estimates indicate that barges can be unloaded and recovered in swells up to eight ft.--a sea condition that cannot always be counted on in an amphibious operation.⁵⁸

There is one favorable characteristic that the LASH has when compared to the other commercial ships addressed thus far. The 500-ton lift capacity and large clear topside configuration raise the possibility of the LASH being suitable as a LCAC vehicle carrier. There is space for six LCAC vehicles on the typical LASH ship; however, due to the shortcomings cited, the LASH vessel in its unmodified configuration is not suitable for use in the AE.⁵⁹

The weather deck of the LASH ship has potential for the storage of vehicles, landing craft and possibly the LCAC. Below-deck spaces could be used for vehicles and cargo that could be loaded on barges or into containers.

The following modifications would be needed before consideration could be given to use the LASH ship in the AE:

- (1) convert existing crew accommodations to provide USN operational spaces, communication central and billeting for ship's officers

- (2) convert one cargo cell for the billeting of 300 troops of the landing force

- (3) convert one hold for the billeting of 330 crew members requiring 8,580 sq. ft. and personnel-support facilities requiring 28,050 sq. ft.

- (4) provide adapter hardware to permit the gantry to hoist an LCM-8 and LCAC vehicle

- (5) install two helicopter-landing positions with associated flight operational and safety equipment

- (6) install weapons system for defense of the ship forward and aft

- (7) install surface search radar, signal bridge, communication central and internal communications system

- (8) install USN damage-control equipment, pumps and fire-fighting equipment.⁶⁰

The estimated cost of the modification cited above is 88 million dollars.⁶¹

Even with the prescribed modifications, the ship's usefulness in the AE is questionable. Barges loaded with cargo, vehicles or containers are not suitable for use in an assault. In the AE the only possible use for a modified LASH ship would be the delivery of landing craft or LCAC vehicles. When the capacity is compared against the cost of ship modification and the survivability risk, it is not sensible to use the modified LASH barge carrier in the assault phase of an amphibious operation.

On the other hand, the LASH ship offers great potential in the AFOE. In this phase of the amphibious operation, quick unloading is not as critical. The volume of cargo is more important. Building up the logistical support area with the necessary equipment and supplies to sustain the landing force ashore is of the utmost importance in the AFOE. An 8 x 8 x 20-foot container can carry up to 20 tons of cargo. The LASH can carry 228 of these containers.⁶² The 500-ton barges that the LASH is capable of carrying can be preloaded with containers, breakbulk cargo or vehicles. The LASH's self-unloading capability makes it particularly suitable for an amphibious operation. The fact that it is solely dependent on one gantry is still a disadvantage in the AFOE. However, rapid unloading, although still important, is not as critical in the AFOE as it is in the AE. The risk of a mechanical breakdown of the gantry is still a concern; however, more time is available to effect repairs in the AFOE than in the AE.

Another advantage is that the pre-loaded barges can serve as temporary storage facilities. They are called floating dumps and preclude the establishing of elaborate logistical facilities ashore.⁶³

In conclusion, because of its cargo capacity, self-unloading ability and the capability of providing floating dumps, the LASH is a vessel with high potential for use in the AFOE of an amphibious operation.

Figure III-25 shows a full length view of the Delta Steamship Line's C-9 LASH ship lying at anchor while working barges. The large barge crane on the extender rails at the stem of the ship is unloading a barge and a tug is waiting to receive the barge at the moment that it is released from the load frame. Forward on the ship is the container crane. On these ships, cranes are carried in the forward cells and barges aft.⁶⁴ Currently there are 14 LASH vessels under American registry.⁶⁵

e. Seabee Barge Carrier

Similar to the LASH, the Seabee uses barges and containers on the upper deck to speed loading and unloading, to function as storage spaces in transit and as vehicles for further cargo movement from port terminals. The Seabee loads barges horizontally from the stern on three deck levels. These decks could be used for storing landing craft vehicles and other cargo in place of barges.

As a potential LCAC carrier, the Seabee has fewer problems with landing than the LASH ship. The fore and aft size of the LASH gantry accommodates a 30-foot distance between lift points. The LCAC is about 93 ft. long. That means 30 ft. will be under the gantry and the remaining 63 ft. will be extended further aft. Therefore a special adapter is required for the LASH gantry.⁶⁶ The Seabee offloading is accomplished by a stern elevator with a 2000-ton capacity. Therefore is is more suitable for LCAC unloading. The one limitation is that the Seabee has the capability of launching one craft every 30 to 40 minutes; more than double the time of the LASH.

The LASH has a motion compensation device that allows it to unload in swells of up to eight ft. The Seabee does not have a device of this type. Consequently, the craft being unloaded would take the wave action directly. This could have damaging effect on supplies and equipment loaded into containers and on to barges. The LCAC is of light construction and is very susceptible to damage with rough handling. Thus, the Seabee has a serious shortcoming if the LCAC has to be offloaded in anything but a calm seastate.

Since the failure of the stern elevator could completely eliminate the Seabee's offloading capability, a failure occurring during the AE would have serious effects.⁶⁷

The equipment and supplies would essentially be locked into the Seabee with no alternative means of offloading.

The Seabee, as the other merchant-ship configurations discussed, lacks the essential equipment for operation in the AE:

- (1) lack of adequate COMM/ELECT equipment and spaces to house it
- (2) lack of damage-control equipment
- (3) lack of helicopter-landing area
- (4) lack of living accommodations for the crew and embarked personnel
- (5) no underway replenishment capability
- (6) lack of appropriate cargo in the AE for 1000-ton barges
- (7) unsuitability of its containers for use in the AE.⁶⁸

It can be concluded that the unmodified Seabee is not suitable for use in the AE because of the reasons cited above.

In order to consider the Seabee for use in the AE, the following modifications would have to be made:

- (1) conversion of 44,850 sq. ft. of cargo space for billeting and personnel-support functions for 373 crew members and 300 embarked troops
- (2) modification of support pedestals to accommodate vehicles, landing craft and the LCAC
- (3) installation of landing areas for helicopters and their associated operational and safety equipment

(4) installation of CIWS forward and aft for the defense of the ship

(5) installation of surface search radar, signal bridge, yardarms, combat-information center, communication central and internal communication system

(6) installation of one emergency diesel generator

(7) installation of damage-control equipment, pumps and fire-fighting equipment.⁶⁹

The estimated cost of the modifications is 102 million dollars.⁷⁰

The modified Seabee would have substantial capacity for transporting landing craft, LCAC's and other vehicles. The Seabee elevator has the capacity to hoist landing crafts or LCAC's loaded with battle tanks; however, this has not been tested and the sensitivity of the elevator to seastate makes this practice questionable.⁷¹

It can be concluded that the type of cargo (1000-ton barges), the 40-minute cycle time for unloading craft, and the sensitivity to seastate make the Seabee unacceptable for the AE even with the modifications listed above.

As with the LASH, the Seabee has the advantages of breakbulk cargo, containers, and pre-loaded barges with up to 1,000 tons of cargo. Due to its self-sustaining quality, it does not require a pier facility to unload. The elevator located on the stern of the ship has the capability to go below the water line, therefore, barges can be floated and picked up in the open ocean. The large capacity of the

elevator (2,000 tons) gives the ship the capacity to unload or pick up outsized loads. The Seabee barge carrier also has the capability to carry warping tugs, cranes, mooring gear and other equipment that can be utilized to establish a barge-handling, discharge and offshore storage facility. Chapter IV of this study will address this facility in depth.

Due to the above reasons, it is concluded that the Seabee barge carrier has potential for use in the AFOE. Its dependence on its single barge elevator for loading and unloading is still a significant shortcoming; however, it is not as critical in the AFOE as it is in the AE.

The climate leans more toward logistical loading and unloading and there is more flexibility as well as time, men and equipment to deal with a problem such as the failure of the Seabee elevator. Figure III-26 shows a Seabee ship at sea carrying both barges and containers. Notice the stern elevator locked into sailing position between the main deck and upper deck. This ship is self-sustaining with respect to its barges, but requires support and assistance with containers from an external crane, capable of lifting and placing containers into position on the upper deck of the ship.⁷² Currently there are three Seabee vessels sailing under a U.S. flag.⁷³

f. Trimariner Barge Carrier

The Trimariner is a new concept in commercial shipping and has only recently been produced. The fact that

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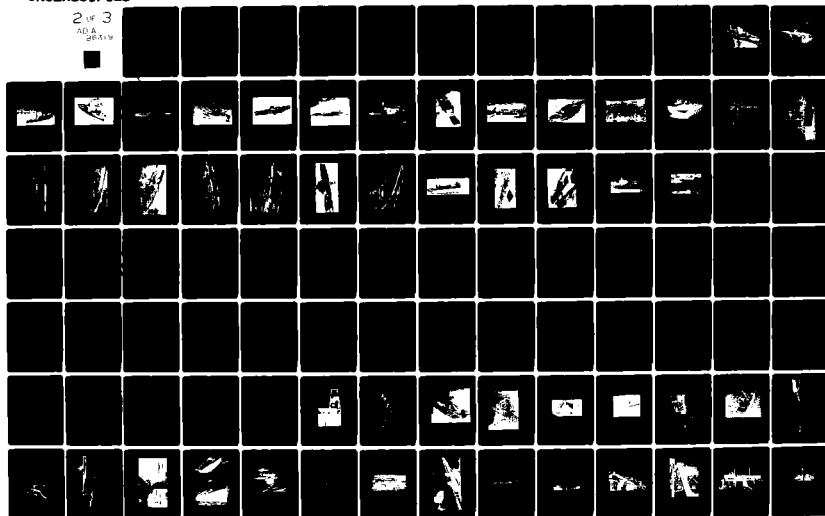
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it has a wet well-deck gives the ship vast potential for use in an amphibious operation. The ship can be compared to the USN amphibious dock landing ship (LSD), pictured in figure III-2. The Trimariner's cargo capacity is twice that of the LSD. Its speed, however, is significantly less. The USN LSD is capable of 22 kn., whereas, the Trimariner is capable of only 16 kn.⁷⁴

The Trimariner's well-deck is open at the stern. The USN LSD has an enclosed well-deck with a stern gate. Ballast tanks allow change in draft. In order to load, the ship is ballasted and the loaded barges are warped into the well-deck. The ship is then deballasted and the loading is complete. Offloading is merely the above procedure in reverse.

The biggest advantage of the Trimariner in the AE would be its ability to embark large numbers of landing craft. It has the capacity for 50 LCM-6's, compared to 20 in the LSD and nine in the amphibious transport dock (LPD).⁷⁵

The speed of the ship is a significant shortcoming. USN ships are designed to steam in formation at 20 kn. for extended periods of time.⁷⁶ The Trimariner would require the fleet to travel at 16 kn. This is considered unsuitable for an ATF.⁷⁷

The Trimariner's open well-deck restricts cargo to barges or other types of craft. The USN amphibious ship with its closed stern gates is capable of carrying other

types of cargo in the wet-well, e.g., vehicles can be driven directly into the wet-well. This is a capability not possible with the Trimariner.⁷⁸

In addition to the slow speed and the lack of cargo flexibility, the Trimariner has the shortcomings common to all commercial ships in the AE:

- (1) inadequate COMM/ELECT capability
- (2) inadequate damage-control equipment
- (3) inadequate accommodations for crew and members of the landing force
- (4) inadequate handling and unloading of the ship's 6000-ton barges
- (5) inadequate facilities for helicopter-landing area.⁷⁹

Due to these shortcomings, it is concluded that the unmodified Trimariner is not suitable for use in the AE.

In order to consider the Trimariner for use in the AE, improvements related to the handling of landing craft must be made. Due to its configuration, the Trimariner could probably embark landing craft as fast as any amphibious ship; however, capabilities would be needed to protect the wet-well from salt water to facilitate craft and vehicle maintenance during transit. A wooden deck overlay or other cushioning material would have to be installed to prevent damage to the bottom of the landing craft. A craft tie-down system would be needed to prevent shifting in heavy seas. In addition, the following modifications would be needed:

(1) install CIWS forward and aft along with fire-control system and magazines

(2) install surface-search radar, signal bridge, central communication and internal-communication system

(3) install two emergency-diesel generators

(4) install damage-control equipment, pumps and fire-fighting equipment

(5) install one helicopter platform with operational and safety equipment

(6) install one additional ship-service generator.⁸⁰

The result would be a ship the size of a World War II LSD that would have the capability of carrying LCAC's and launching them while underway.

Even with the above modifications, the ship's speed of 16 kn. and the resulting inability to keep up with the 20-knot speed of the ATF, eliminate the Trimariner for consideration in the AE.

The Trimariner with its wet-well capacity would be a valuable asset in the AFOE. The non-self-sustaining containership which will be discussed in more detail in the next section, does not have the capability to unload containers without container-handling equipment located at a port facility. The Trimariner has the capability to transport large barge cranes to the AOA. These cranes could be used to unload non-self-sustaining containerships, which is a critical problem when considering the use of merchant ships. The 6000-ton

barges projected as a normal load for the ship are too large for the warping tugs available in the AOA.⁸¹

Due to its capability to deliver barge cranes to the AOA, the Trimariner offers excellent potential for use in the AFOE. If for no other reason, it is capable of solving at least part of the container discharge problem from non-self-sustaining container ship.

A recent development from one of the North Atlantic Treaty Organization (NATO) countries can be compared to the Trimariner. The Baco-Liner 1 (barge container) has been employed in West Germany. It has the float on/float off principle of the Trimariner. The vessel takes on barges through double bow doors. The barges are carried in two enclosed dock spaces separated by a bulkhead along the ship's center line. Each dock space is able to take six of the special Baco barges. These barges are units of 800-ton capacity or just a little smaller than the Seabee barge. Alternatively, the Baco 1 can accommodate 14 LASH barges. On deck containers can be stored and handled by the ship's one gantry crane. The ship's barge and container handling could be done without the use of a pier facility. This total self-sufficient concept gives it an advantage over the Trimariner, which cannot handle containers without an external gantry.⁸²

g. Containership

In the assault phase of an amphibious operation, many of the initial supplies required such as food and

ammunition are carried in individual packs or in small breakbulk packages that provide rapid unloading and quick access. Containerized cargo is not suitable for the AE for the following reasons:

(1) it requires sophisticated container-handling equipment for ship unloading.

(2) it requires a large volume of lighterage with the capacity to handle containers weighing several tons; (this lighterage is not available in the AOA during the assault phase of an amphibious operation--the lighterage is used for the ship-to-shore movement of the assault force).

(3) it requires a sophisticated unloading facility with container handling equipment to unload lighters at the beach (an unloading operation of this type is not feasible during the AE of an amphibious operation).⁸³

Due to the above reasons, it can be concluded that the use of containerships, either modified or unmodified, is not feasible. Therefore, there will be no further discussion of either self-sustaining or non-self-sustaining container-ship relative to its use in the AE of an amphibious operation.

h. Self-Sustaining Containership in the AFOE

The self-sustaining containerships is a converted breakbulk ship that has maintained the on-board cranes and/or booms.⁸⁴ This gives the self-sustaining containership a unique advantage for use in AFOE of an amphibious operation. It has the ability to unload containers into lighters for ship-to-shore movement; however, there is still the problem

of getting the containers across the surf zone, unloaded at the beach and transported inland. This problem will be discussed in more detail in Chapter IV of this study.

Another problem that merits mentioning, although not considered major, is the lack of selectivity in cargo offload. Containers are offloaded in the order that they are stored. This takes away the flexibility of offloading cargo by the supply priorities dictated by the tactical situation ashore.

Other advantages of the self-sustaining containership include its large cargo-carrying capacity and its excellent cargo throughput rates. Due to its cargo-carrying capacity and its loading and unloading capability, it can be concluded that the self-sustaining containership has tremendous value for the delivery of supplies in the AFOE. This is based on the assumption that the container-handling operation at the beach can be solved.

It is worthy of note that as of 1978, 11 of the 18 self-sustaining containerships in the U.S. merchant fleet were over 25 years old.⁸⁵ The trend in containership construction is toward the more commercially efficient non-self-sustaining containership. Therefore, the self-sustained containership cannot be counted on for use in future strategies. The Mormacdraco pictured in figure III-27 is a good example of a self-sustaining containership. The vessel is 666 ft. long with a deadweight of 16,183 tons.⁸⁶

i. Non-Self-Sustaining Containership in the AFOE

The non-self-sustaining containership has the added advantage of being newer and faster than the self-sustaining ship. Large volumes of cargo can be transported to the AOA rapidly. Modern containers carry up to 22 tons of cargo. They are lifted onto the ship, stacked and locked into place for delivery to its destination. The container acts as a protective shelter until the cargo is ready for use.⁸⁷

When analyzing the use of the non-self-sustaining containership for use in the AFOE in an amphibious operation, an additional problem is seen. The newer non-self-sustaining containership cannot be offloaded without the use of an equipment intensive pier facility. Figure III-28 pictures the non-self-sustaining containership, Argonaut, which was completed in early 1979.⁸⁸

D. CONCLUSION

The merchant ship is designed to make point-to-point trips for the delivery of cargo as economically as possible. The amphibious ship is designed to deliver the landing force to the AOA under hostile conditions as expeditiously as possible. The difference in objectives leads to differences in manning, design and on-board equipment.

None of the unmodified merchant ships addressed were found to be suitable for use in the AE. Some of the more general reasons were:

1. inadequacy of accommodations for the expanded crew and members of the landing force
2. inadequacy of radar, COMM/ELECT equipment
3. inadequate damage and fire-control features
4. lack of defensive weapons on board
5. inability to launch landing craft and amphibious vehicles
6. lack of sufficient lighterage plus associated handling and safety problems
7. lack of helicopter-landing spaces that allow for the debarkation of supplies, troops and equipment
8. lack of suitable cargo-handling equipment for landing force, vehicles, equipment and supplies

With extensive modifications, the 20-knot breakbulk ship and cargo/passenger ship could be made suitable for employment in the AE; however, modifications are expensive and time-consuming. Cost could range from 86 million dollars on a breakbulk ship to 105 million dollars on a cargo/passenger ship. In a military contingency, the time and facilities may not be available to perform extensive modifications. Further, both of these ship types are nearing obsolescence and cannot be depended upon for use by the amphibious forces of the future.

Even with extensive modifications, the remaining ship types were not considered suitable for the AE. The reasons for this can be summarized as follows:

1. LASH:

- a. cargo configuration, 500-ton barges, not suitable for assault
- b. inability to perform in surf with more than eight-foot waves
- c. total reliance on single gantry for offloading

2. Seabee:

- a. cargo configuration 1000-ton barges not suitable for AE
- b. total reliance on stern elevator for offloading
- c. elevator's sensitivity to seastate when unloading
- d. slow unloading cycle time

3. Ro/Ro Ship

cannot offload cargo without pier facility

4. Trimariner:

- a. ship speed too slow for AE
- b. open stern exposes cargo in well to hazard or damage

With limited personnel and equipment augmentation, all the ships analyzed are suitable for employment in the AFOE. However, all ships have varying levels of usefulness. One of the major problems that surfaced is the difficulty in unloading ships in the open ocean under hostile conditions. This problem is particularly acute with the Ro/Ro, Seabee and containership. The problem of unloading merchant ships without the benefit of a port facility will be analyzed in

Chapter IV of this study. Table III-3 provides a matrix that summarizes the advantages and disadvantages of the ships analyzed for their suitability in the AFOE of an amphibious operation.

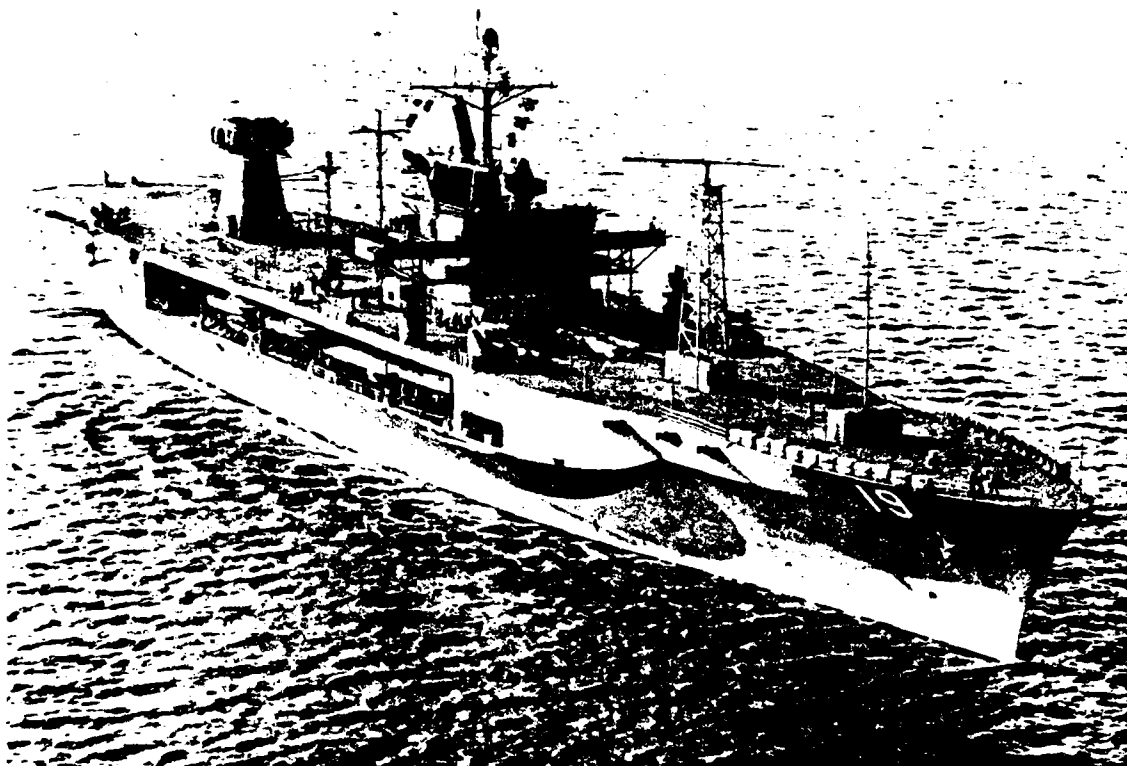


Figure III-1. Amphibious Command Ship (LCC),
Blue Ridge Class.

Source: Amphibious Ships, Landing Craft and Vehicles,
p. 2.

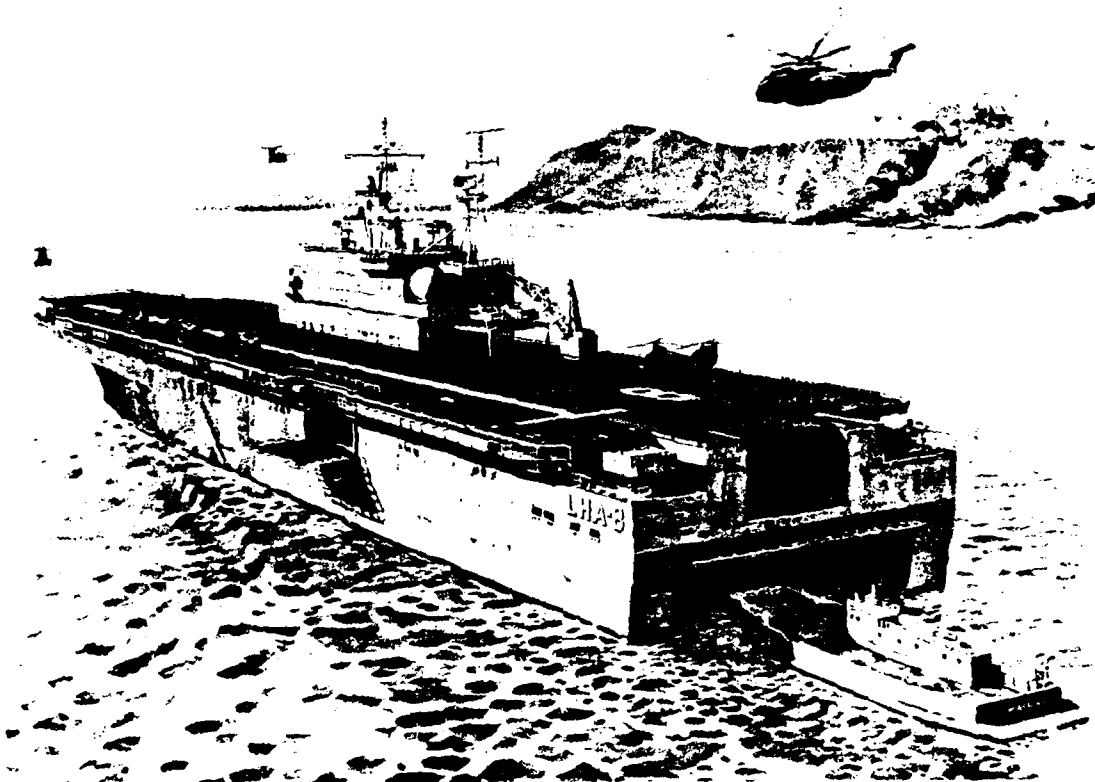


Figure III-2. Amphibious Assault Ship (LHA), Tarawa Class

Source: Amphibious Ships, Landing Craft and Vehicles,
p. 6.

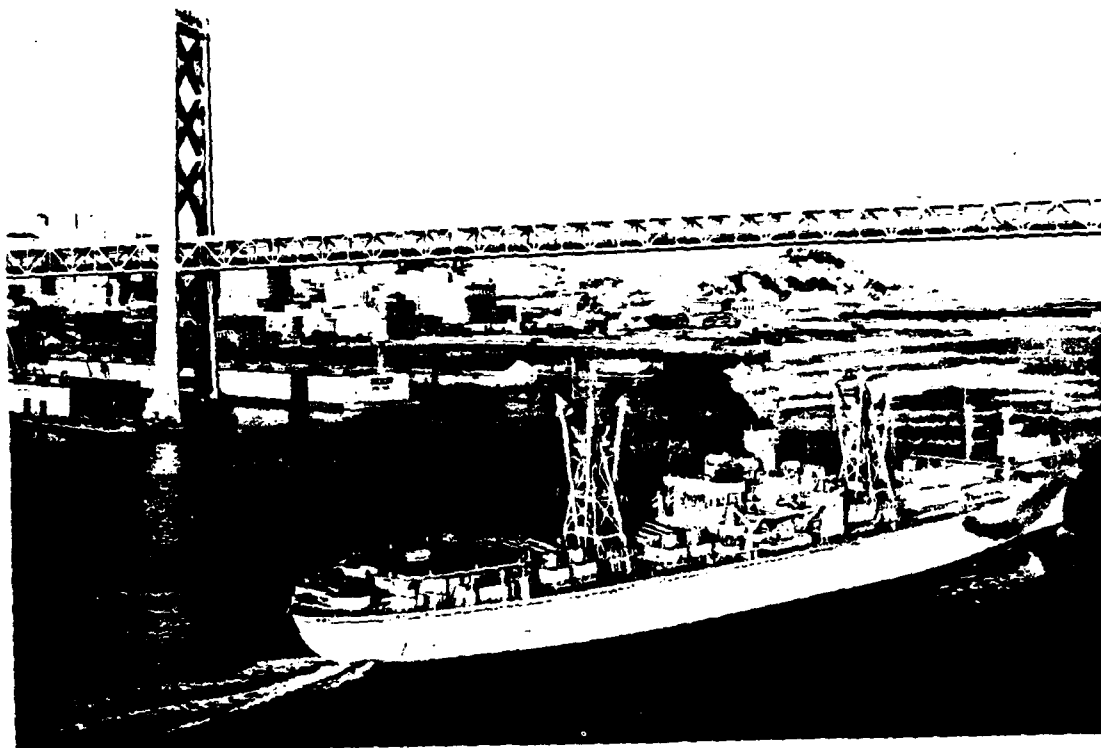


Figure III-3. Amphibious Cargo Ship (LKA), Tulare Class
Source: Amphibious Ships, Landing Craft and Vehicles,
p.8.

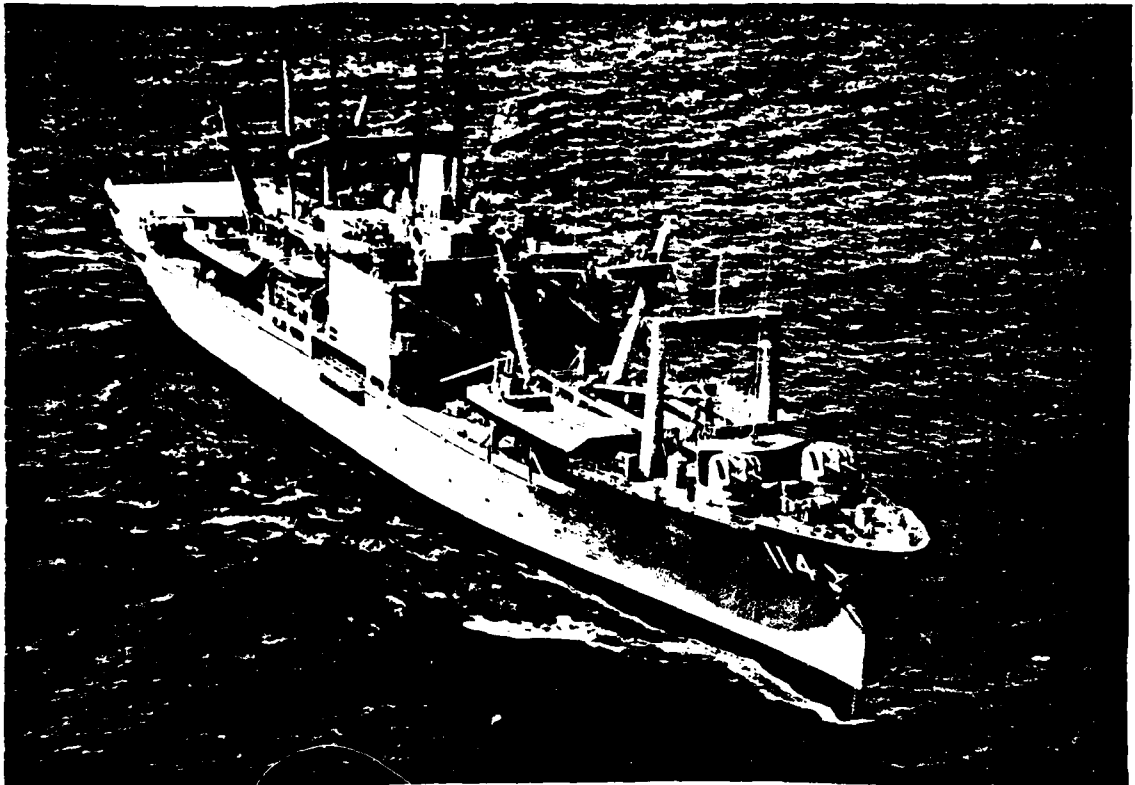


Figure III-4. Amphibious Cargo Ship (LKA), Charleston Class

Source: Amphibious Ships, Landing Craft and Vehicles,
p. 10.

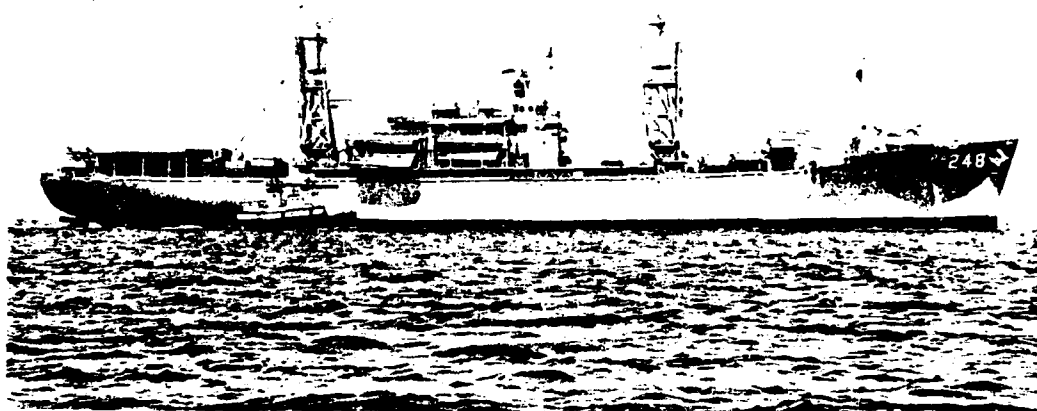


Figure III-5. Amphibious Transport (LPA), Paul
Revere Class

Source: Amphibious Ships, Landing Craft and Vehicles,
p. 14.

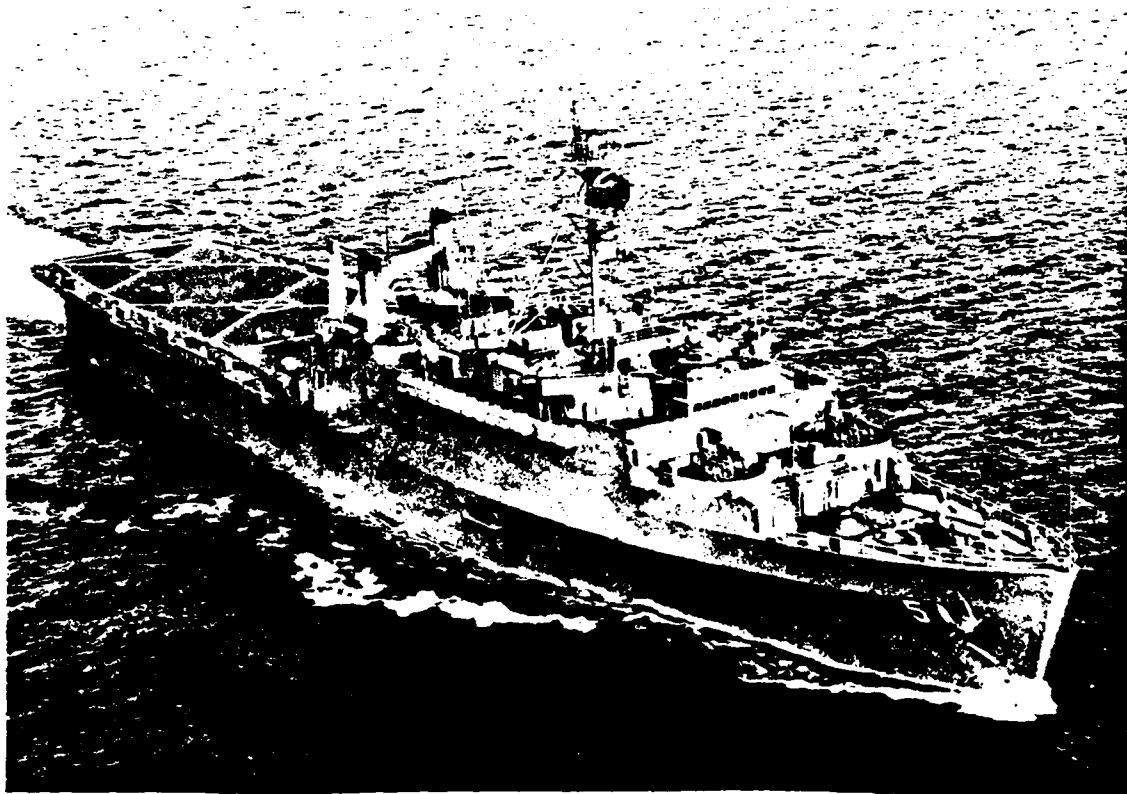


Figure III-6. Amphibious Transport Dock (LPD),
Raleigh and Austin Classes

Source: Amphibious Ships, Landing Craft and Vehicles,
p. 16.

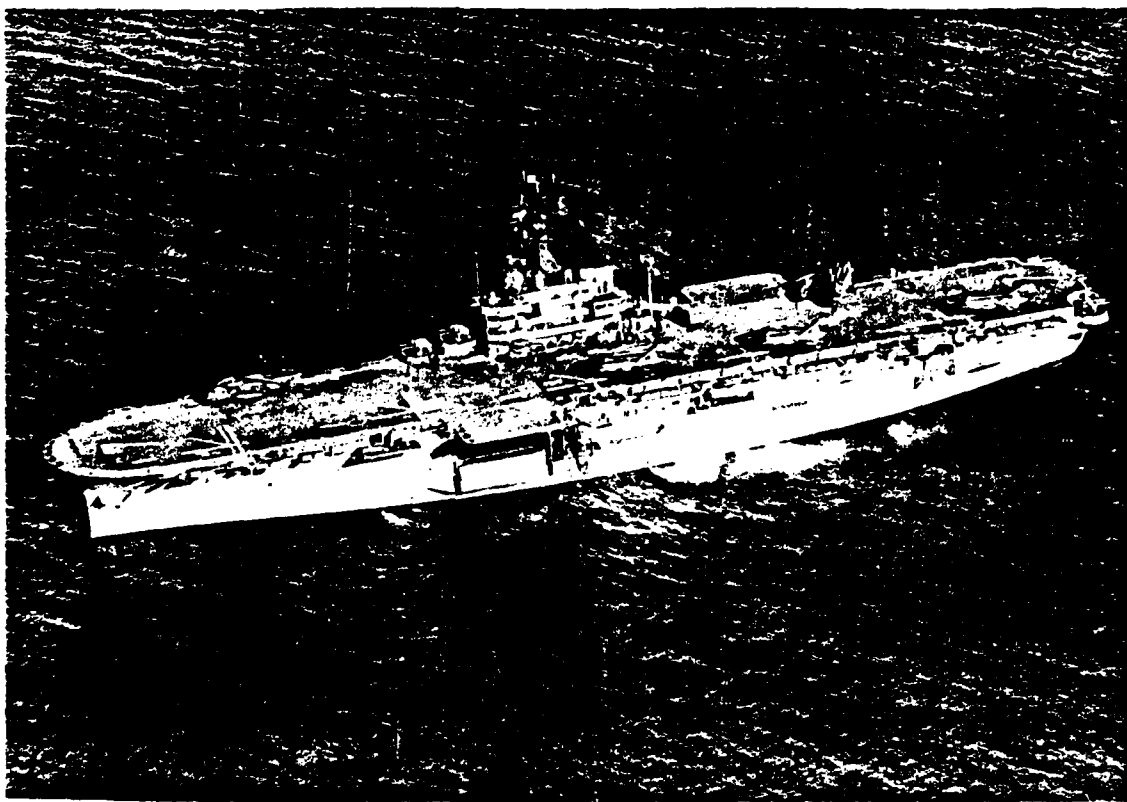


Figure III-7. Amphibious Assault Ship (LPH), Iwo Jima Class
Source: Amphibious Ships, Landing Craft and Vehicles, p. 19.

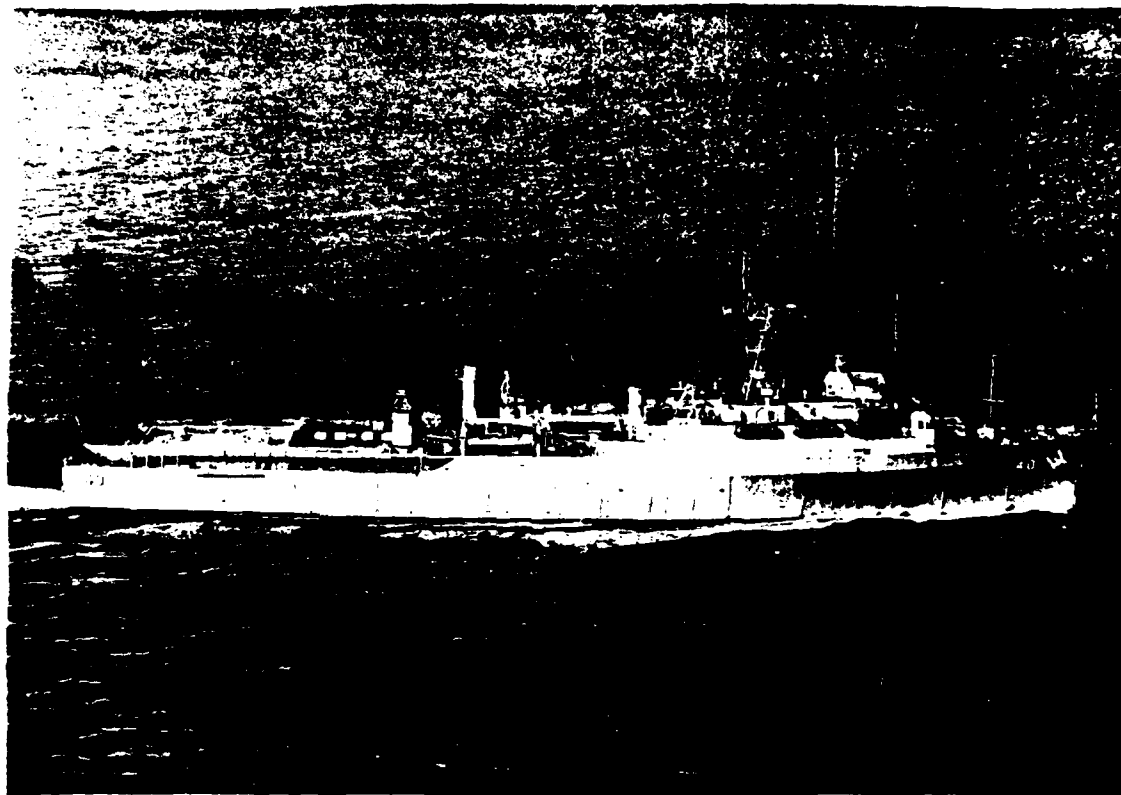


Figure III-8. Dock Landing Ship (LSD), Thomaston
and Anchorage Classes

Source: Amphibious Ships, Landing Craft and Vehicles, p. 22.

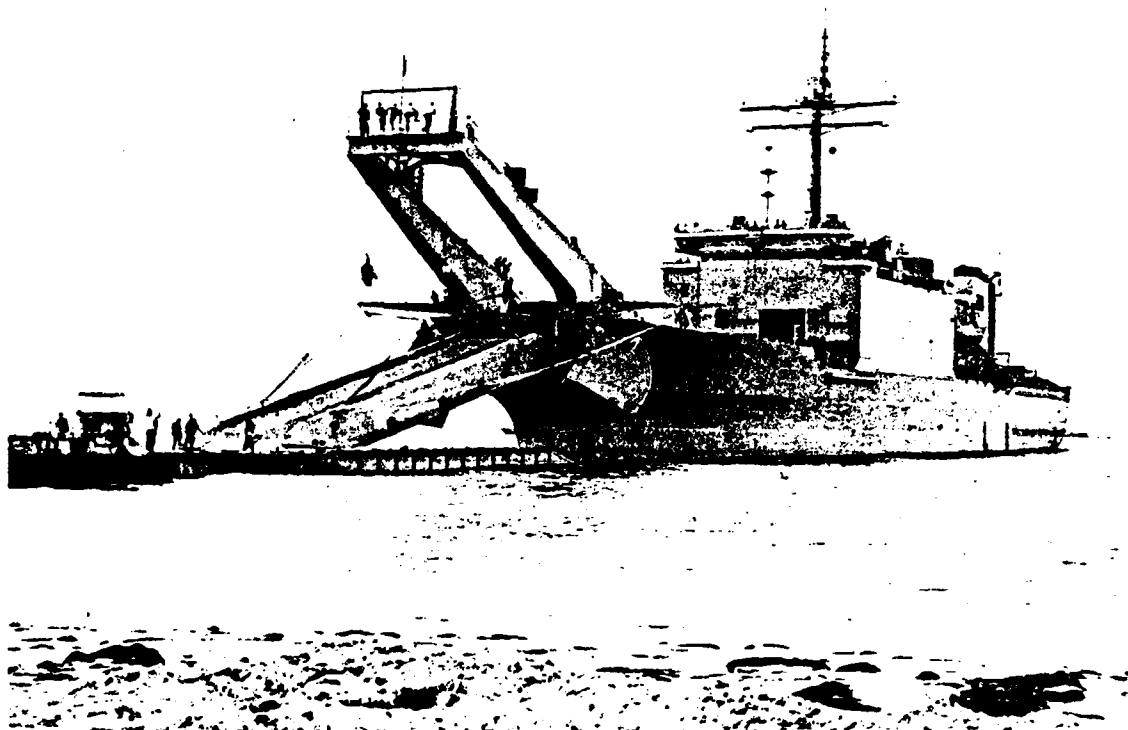


Figure III-9. Tank Landing Ship (LST), LST-1179
Newport Class

Source: Amphibious Ships, Landing Craft and Vehicles,
p. 26.

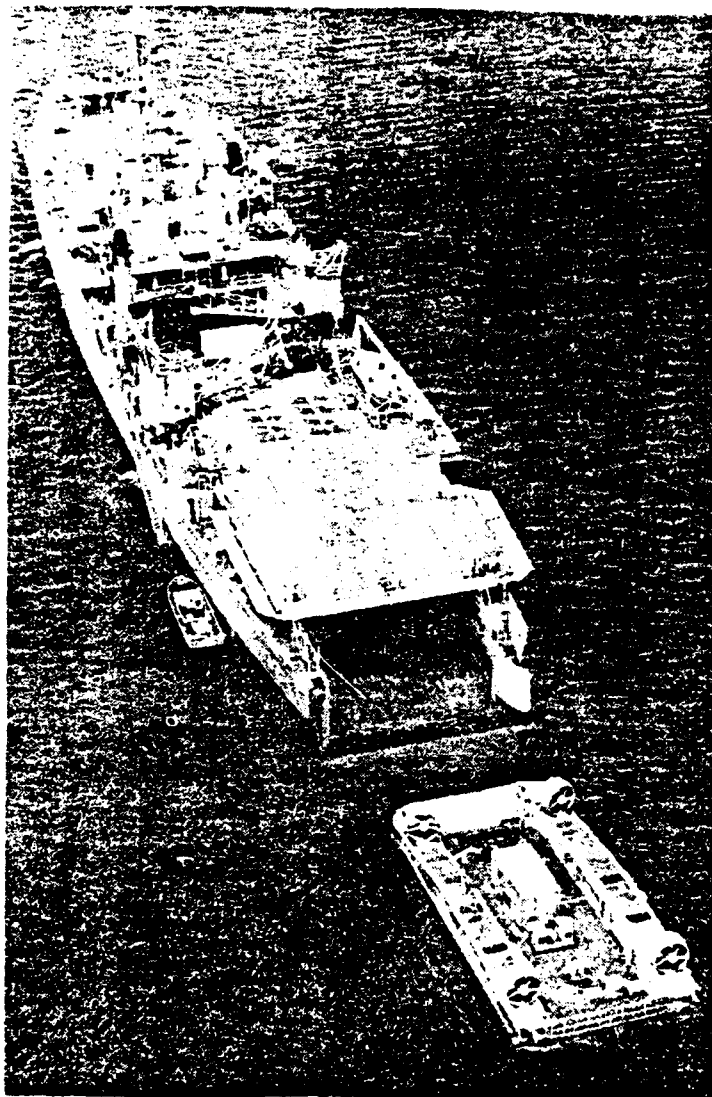


Figure III-10. LCAC, JEFF B.

Source: "Getting More for the Money," p. 20.

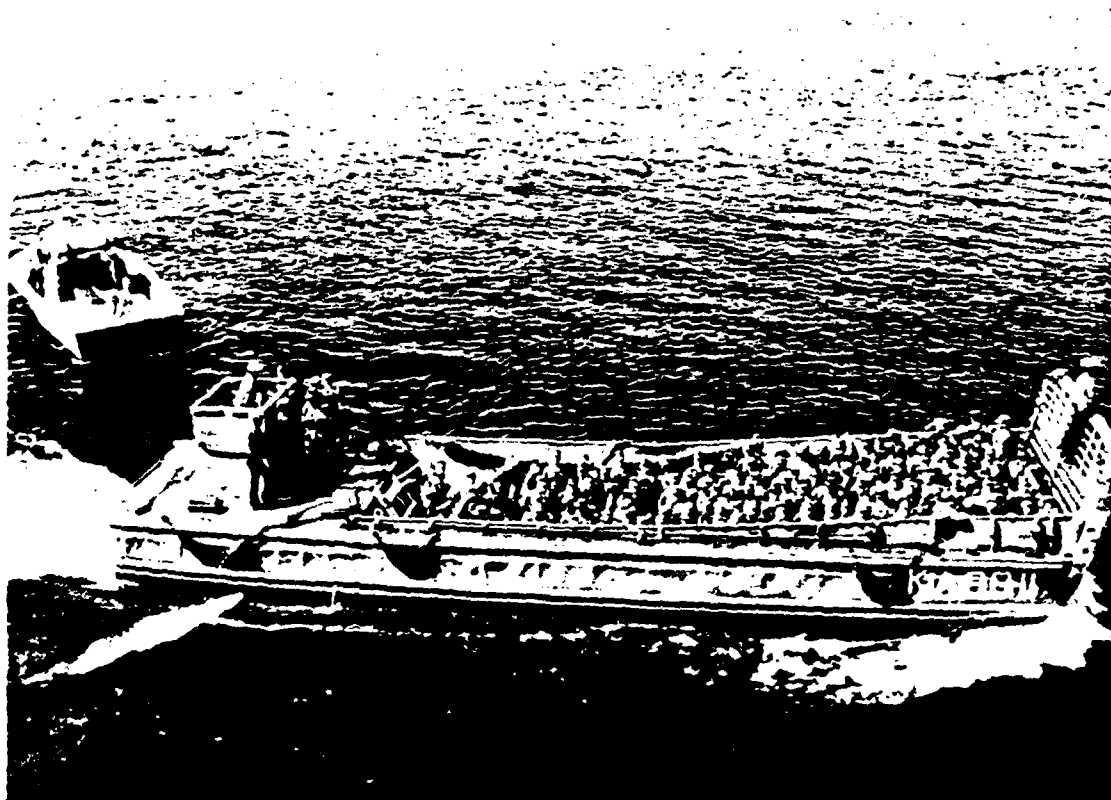


Figure III-11. Landing Craft, Mechanized (LCM),
LCM Mark 6

Source: Amphibious Ships, Landing Craft and Vehicles,
p. 34.

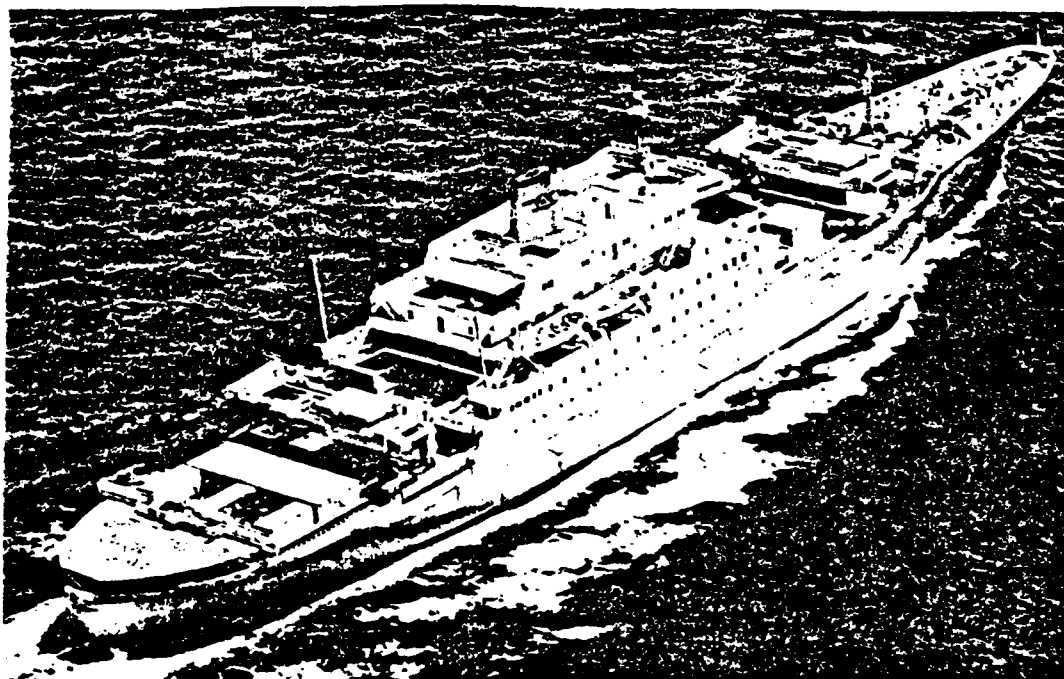


Figure III-12. Cargo/Passenger Ship, Santa Mercedes Class

Source: "The Modern American Merchant Marine," p. 75.

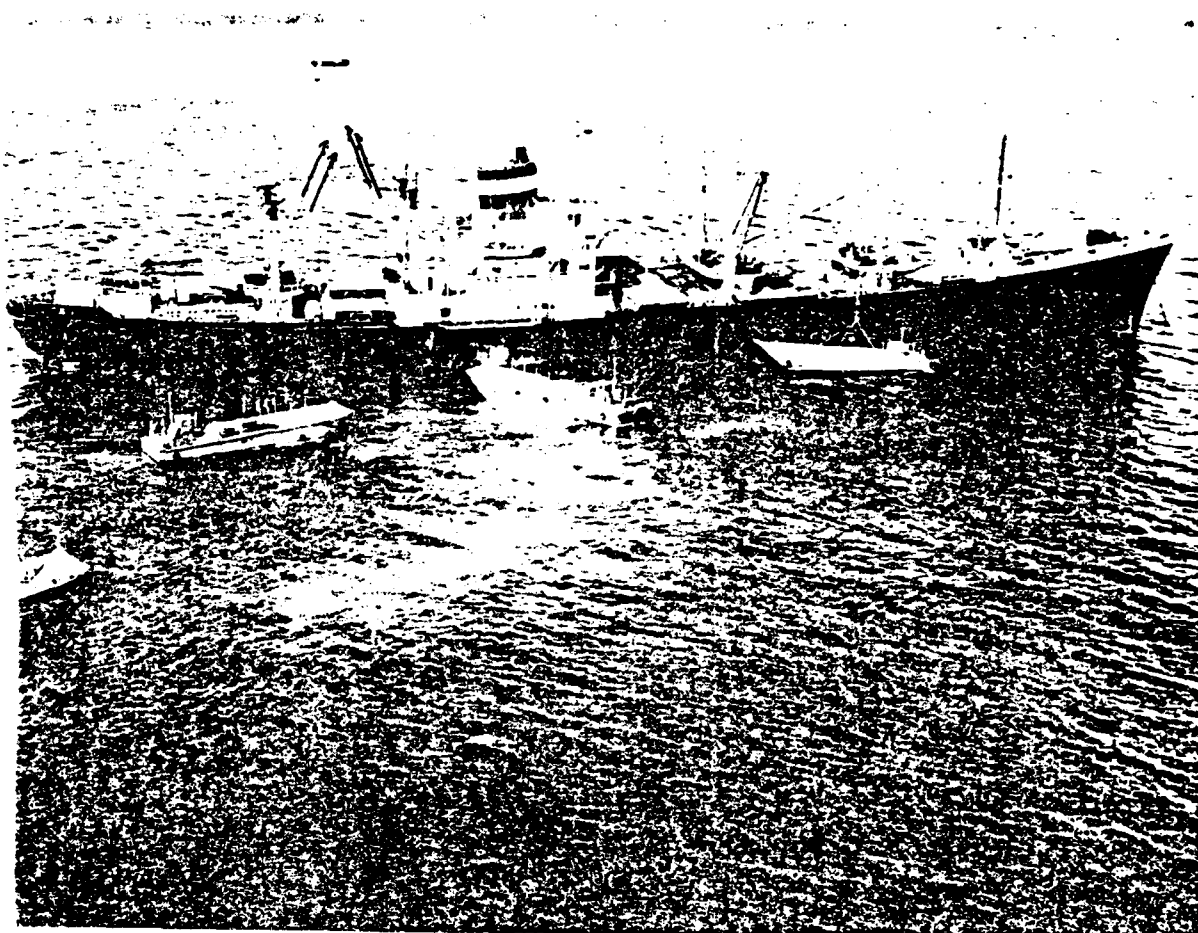


Figure III-13. American Courier Offloading an LCM-8

Source: Report on Results of the Conventional Breakbulk Ship Pretest of the Joint Logistics-Over-The-Shore (LOTS) Test and Evaluation Program, p. A-2.

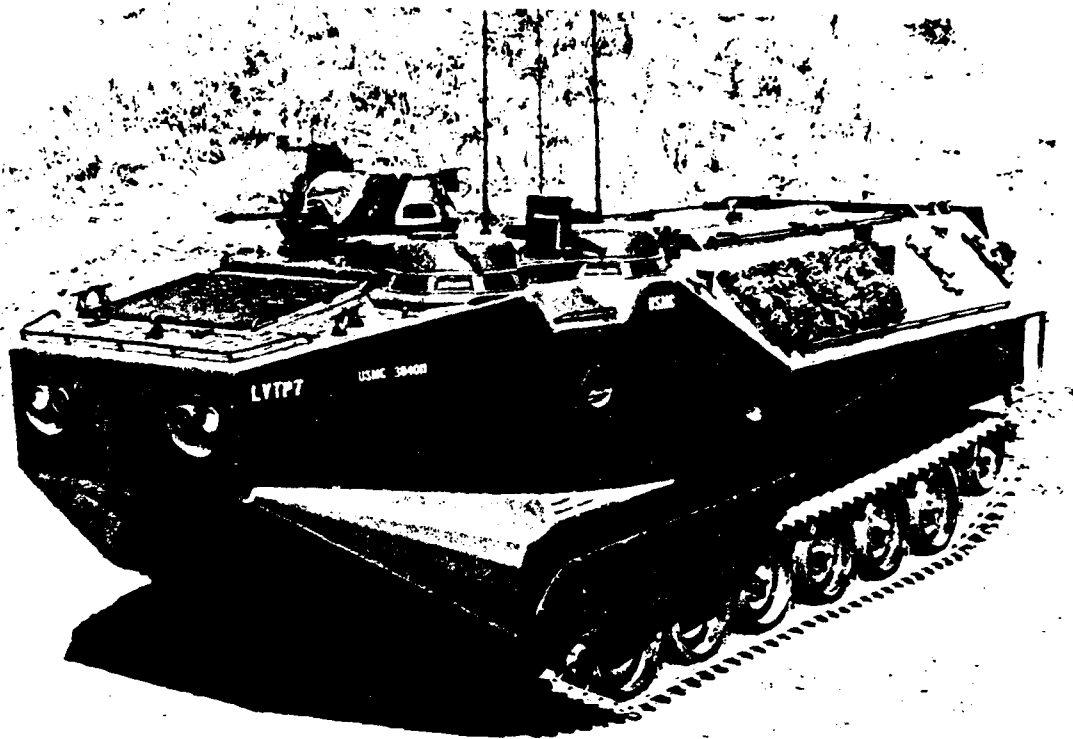


Figure III-14. Landing Vehicle, Tracked, Personnel (LVTP7)

Source: Amphibious Ships, Landing Craft and Vehicles, p. 48.

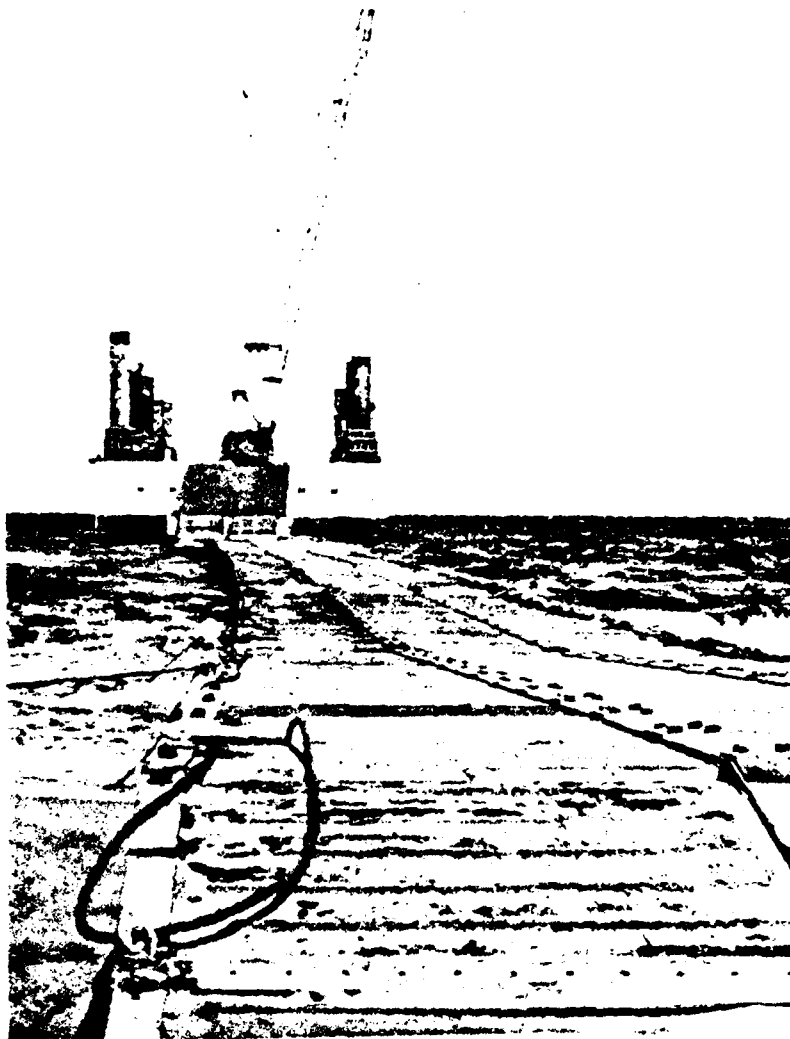


Figure III-15. Floating Causeway

Source: (COTS) Container Offloading and Transfer System, p. 17.

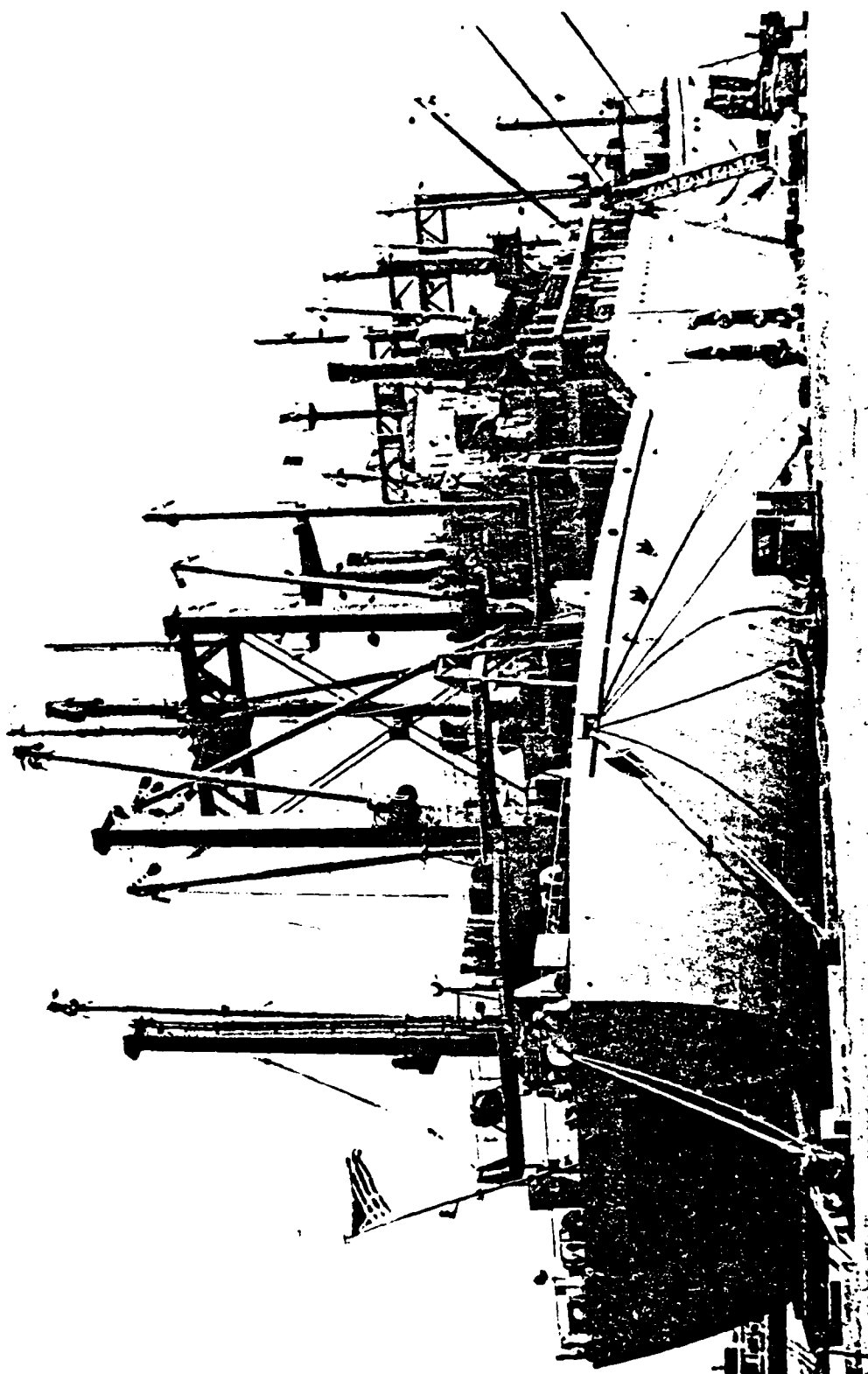


Figure III-16. USNS Comet

Source: Preliminary Report of At-Sea Offloading Concepts for
Roll-on-Roll-off Ships, p. 4.

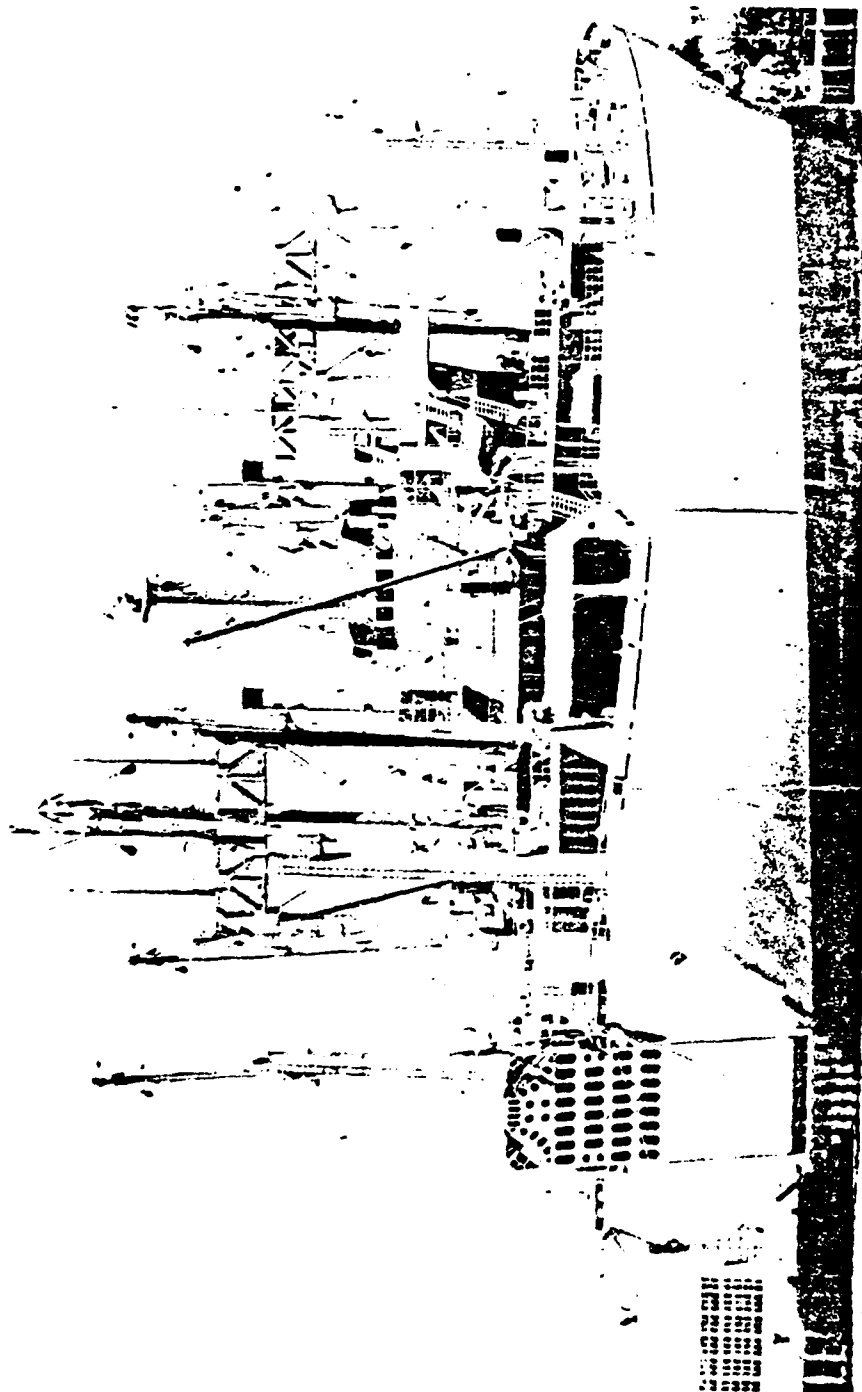


Figure III-17. USNS Sealift

Source: Preliminary Report of At-Sea Offloading Concepts for
Roll-on-Roll-off Ships, p. 8.

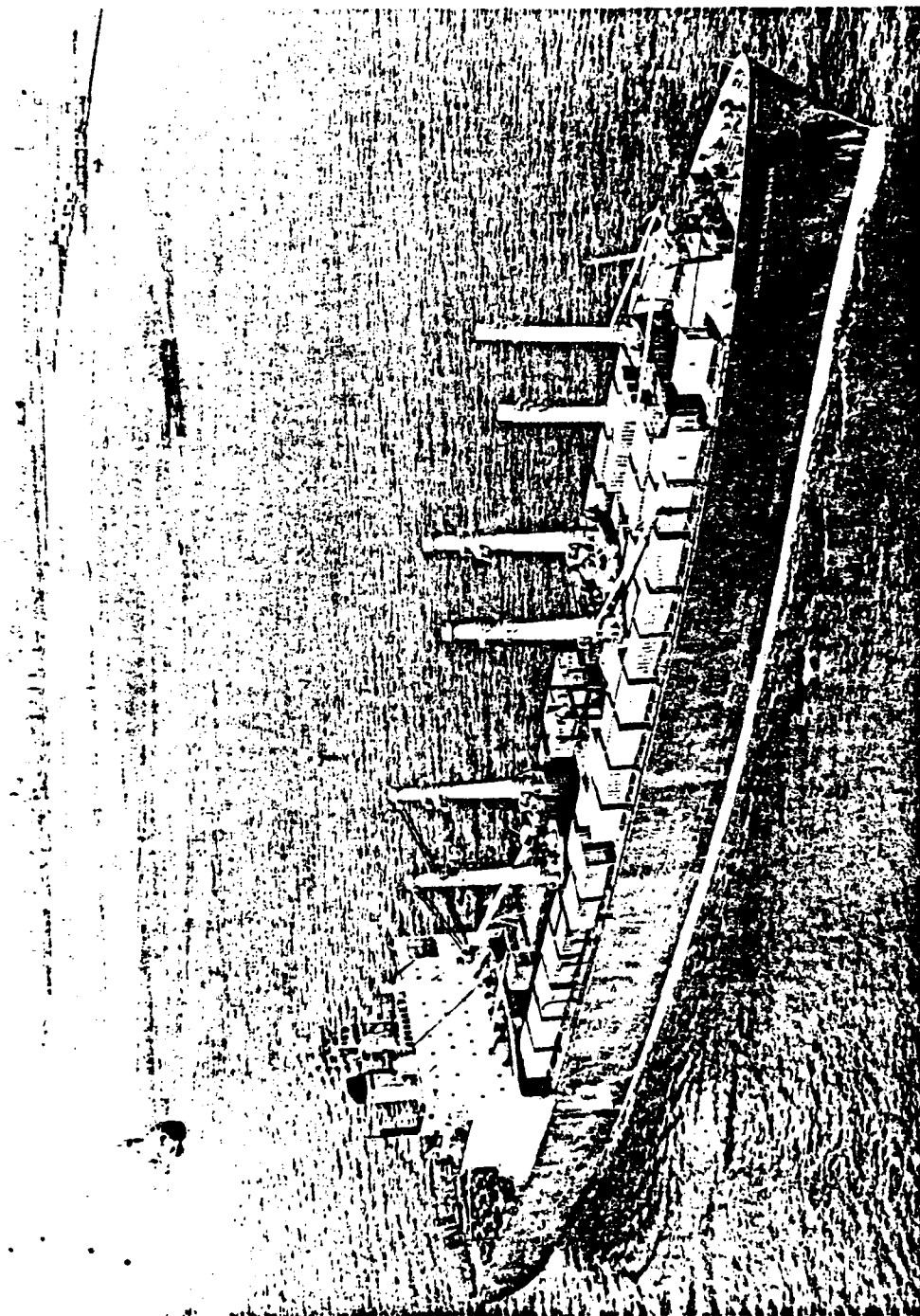


Figure III-18. Admiral Wm. M. Callaghan

Source: Preliminary Report of At-Sea Offloading Concepts for
Roll-on-Roll-off Ships, p. 18.

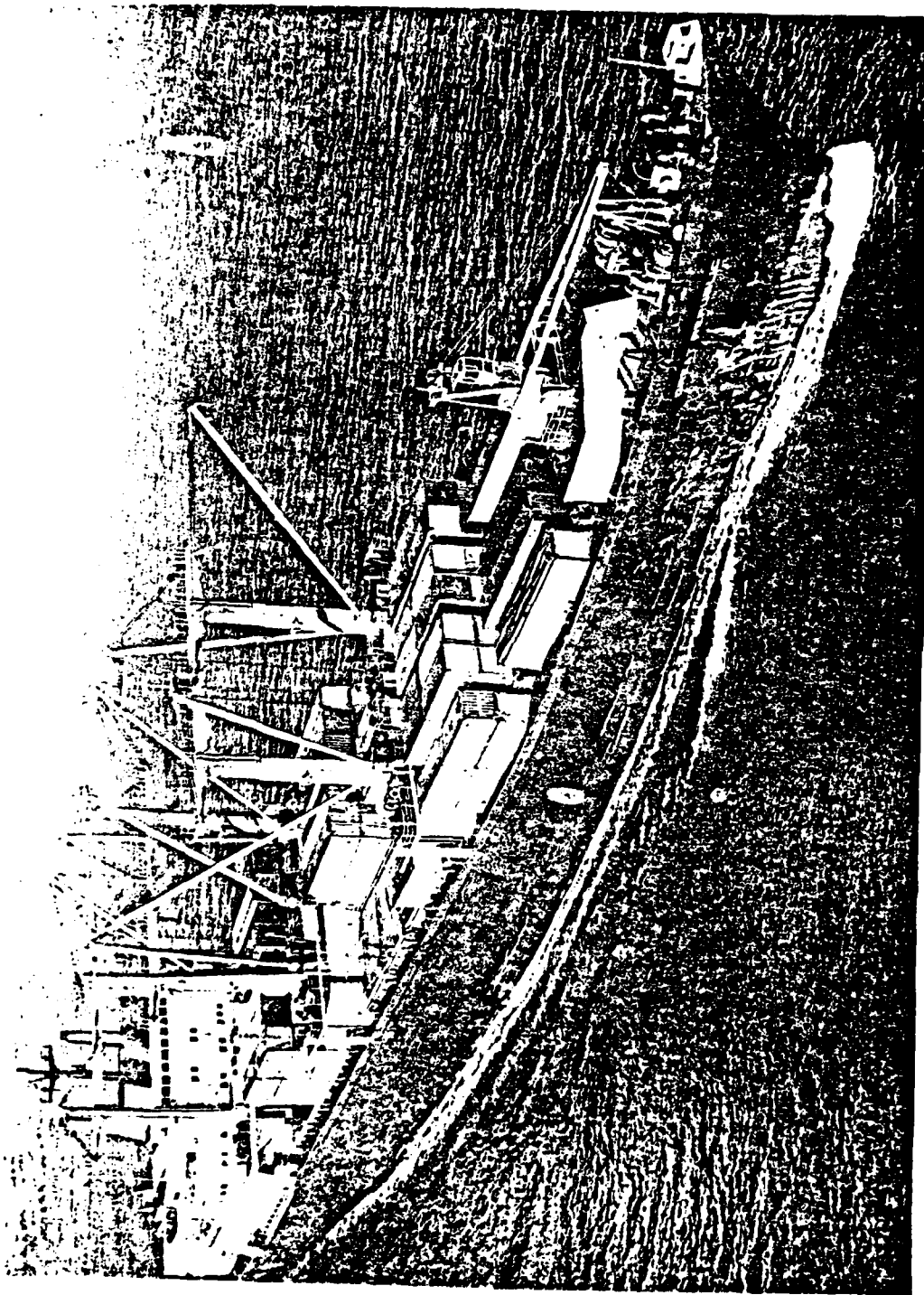


Figure III-19. S.S. Great Republic (Defiance Class)

Source: Preliminary Report of At-Sea Offloading Concepts for Roll-on-Roll-off Ships, p. 23.

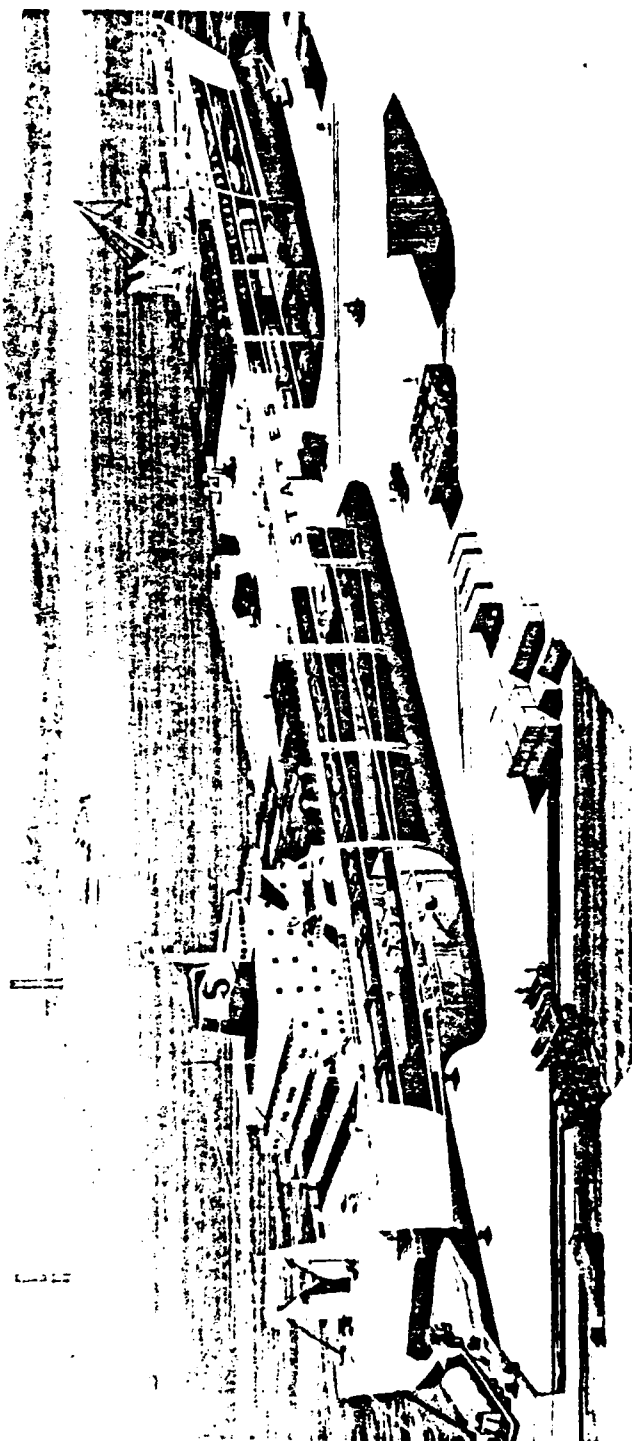


Figure III-20. Maine Class

Source: Preliminary Report of At-Sea Offloading Concepts for
Roll-on-Roll-off Ships, p. 29.

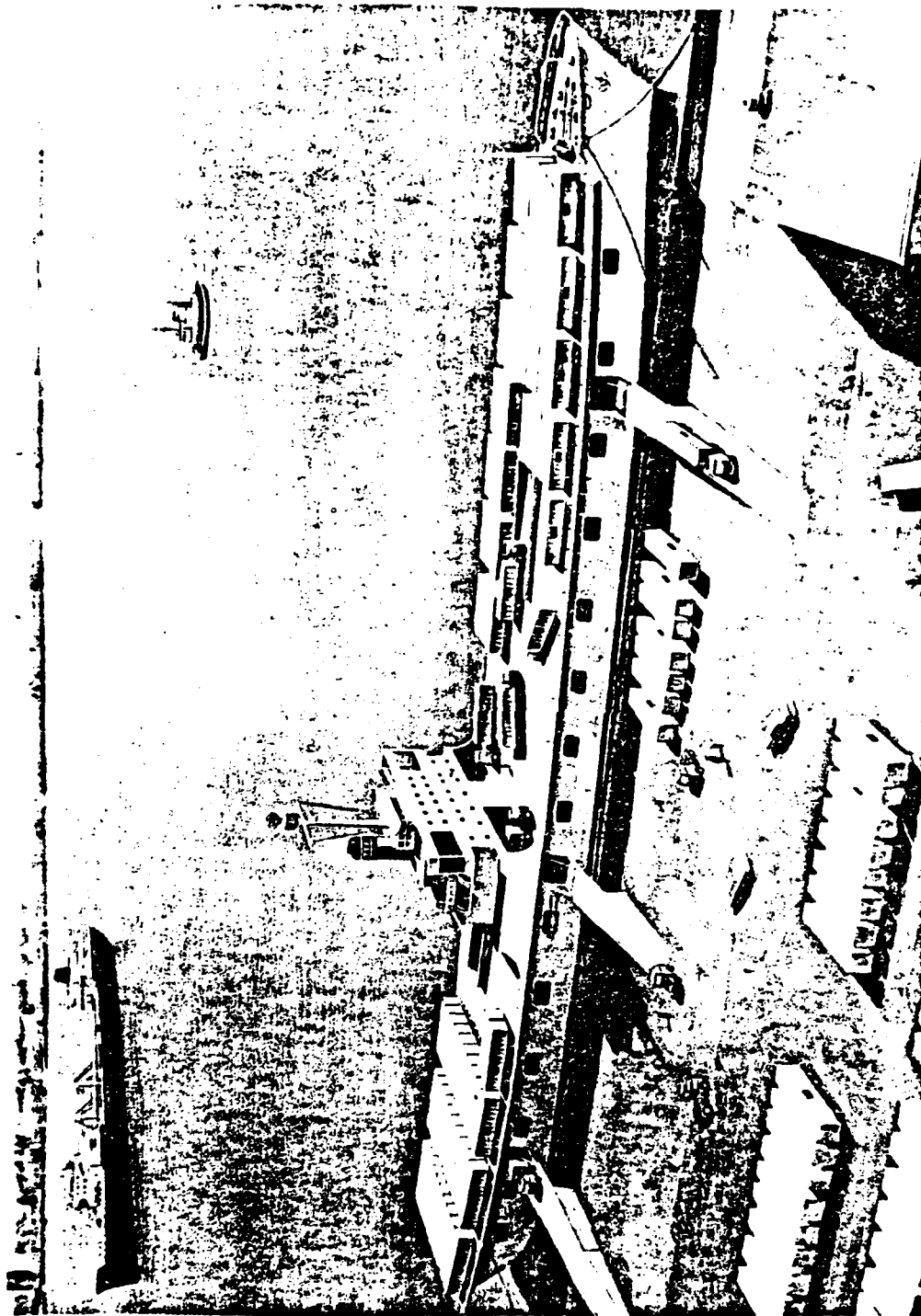


Figure III-21. Ponce de Leon

Source: Preliminary Report of At-Sea Offloading Concepts for
Roll-on-Roll-off Ships, p. 36.

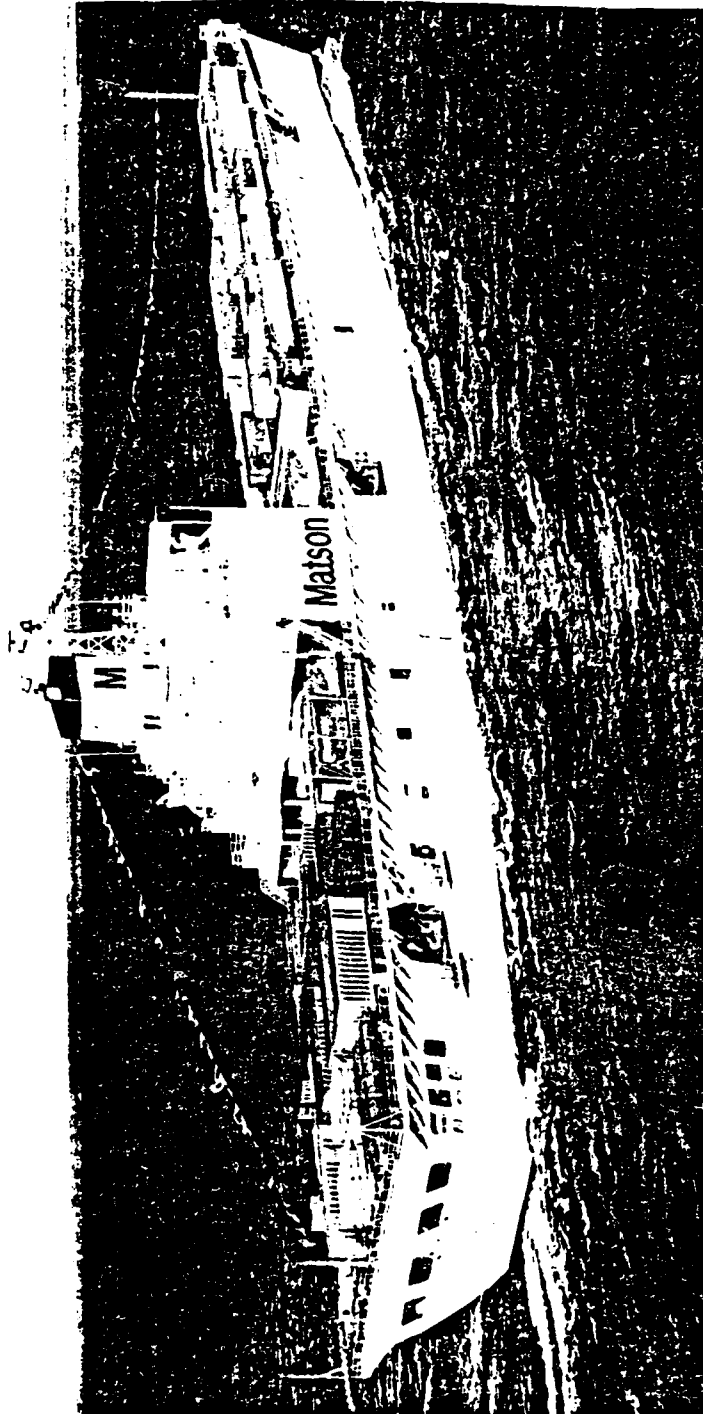


Figure III-22. S.S. Lurline (Lurline Class)

Source: Preliminary Report of At-Sea Offloading Concepts for Roll-on-Roll-off Ships, p. 40.

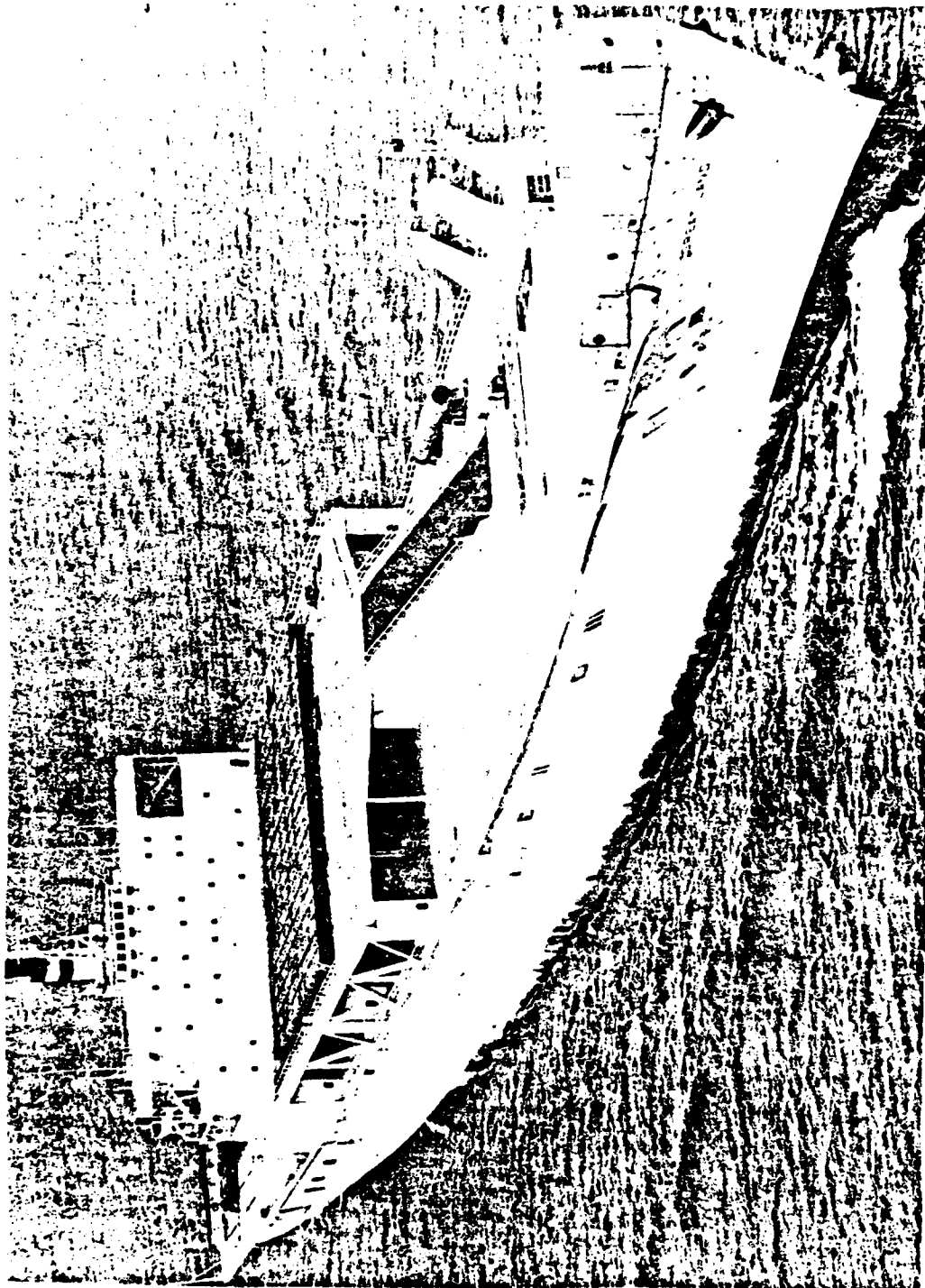


Figure III-23. S.S. Great Land (Great Land class)

Source: Preliminary Report of At-Sea Offloading Concepts for
Roll-on-Roll-off Ships, p. 44.

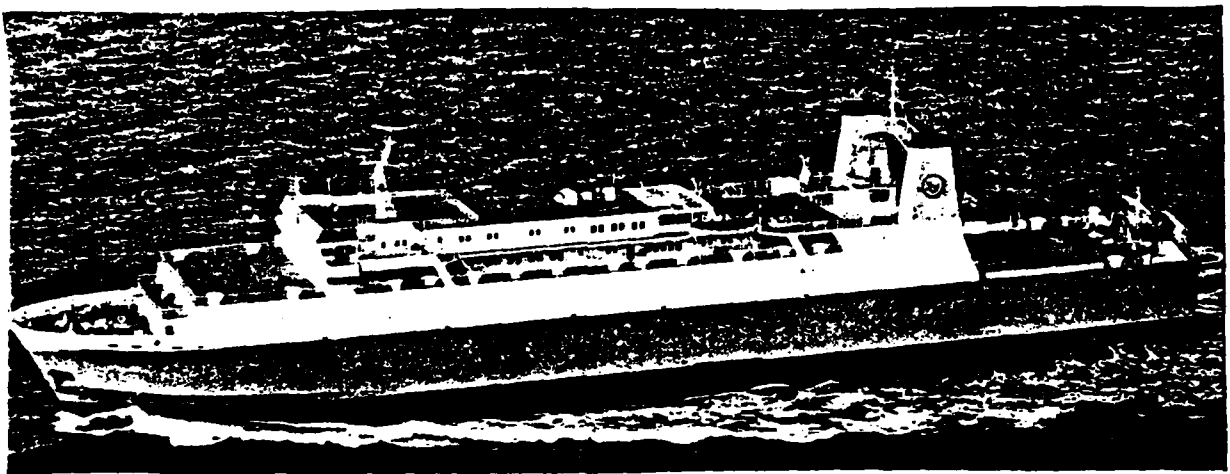


Figure III-24. Baltic Eagle

Source: "Ro/Ro from Rauma Repola," p. 80.

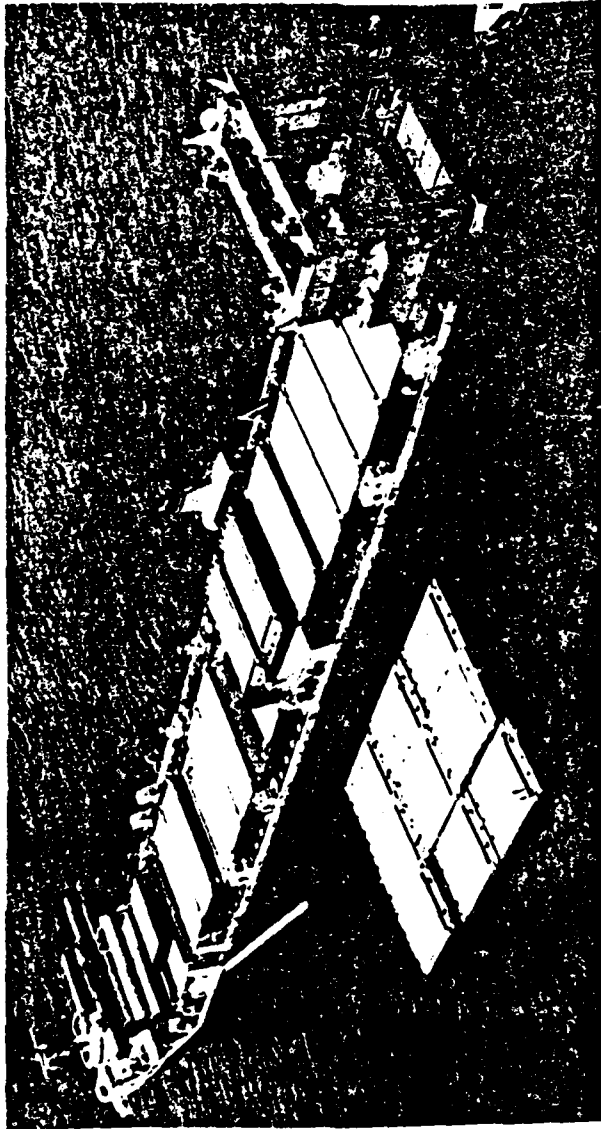


Figure III-25. Delta Sur, Delta S.S. Line, C-9, LASH

Source: Barge Ships in a Seaway, p. 3.



Figure III-26. Seabee Vessel

Source: Report on the Cancelled Seabee Pretest of the Joint Logistics-Over-the Shore (LOTS) Test and Evaluation Program, p. 7.

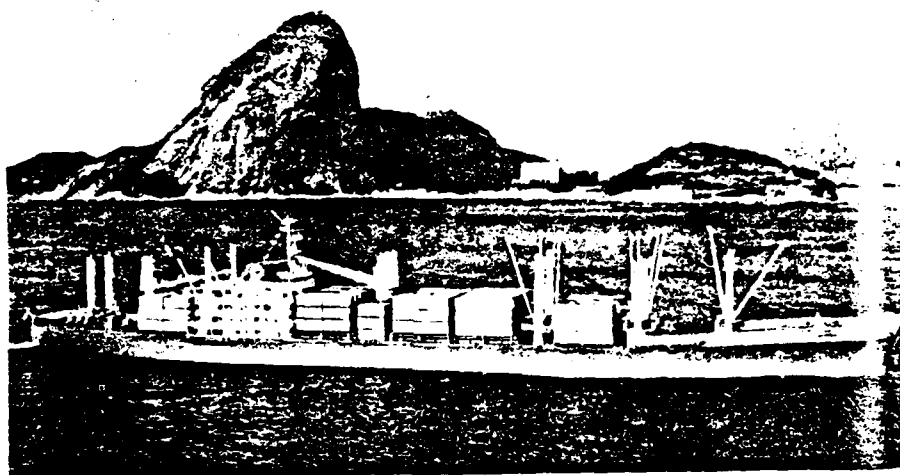


Figure III-27. USS Mormacdraco

Source: "The Modern American Merchant Marine," p. 72.

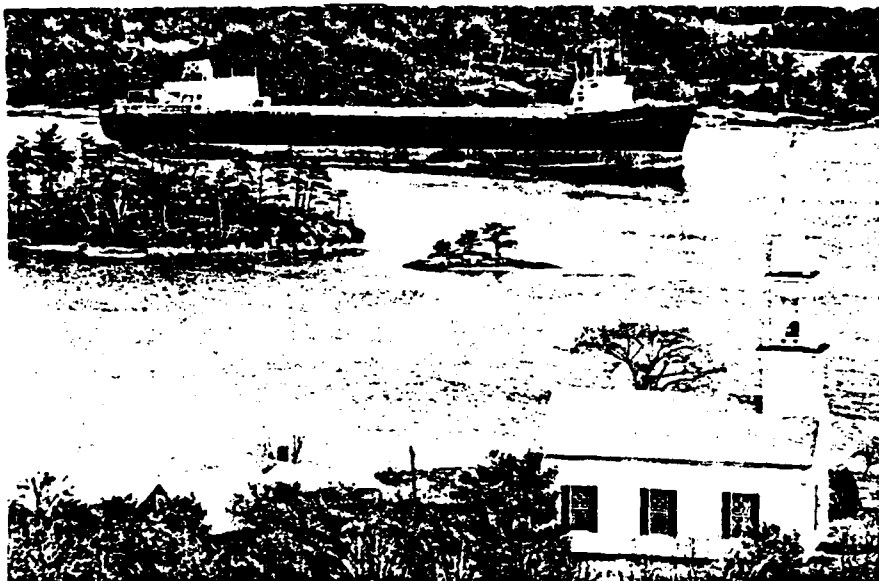


Figure III-28. Non-Self-Sustaining Containership,
the USS Argonaut

Source: "The Modern American Merchant Marine,"
p. 69.

Table III-1

COMPARATIVE MANNING ON A NAVY AMPHIBIOUS CARGO
SHIP (LKA-117) AND A TYPICAL MERCHANT GENERAL
PURPOSE CARGO SHIP (SS AMERICAN CHALLENGER)

FUNCTION	DESCRIPTION	LKA	GP CARGO
<u>EXECUTIVE</u>			
Command	Command and Executive Officers	2	2
Ship's Admin	Clerical and Admin	4	0
Personnel Admin	Personnel Accounting, Records, Reports	4	0
<u>OPERATIONS</u>			
Bridge	Stand Watch on Bridge, Navigation, Wheel, Lookouts	36	12
Signalmen	Send, Receive Visual Messages; Signal Bridge Watch	8	0
CIC	Operate Radar, CIC; Assist in Maneuver	10	0
Radio	Transmit, Receive and Process all Telecommunications	13	1
Electronics	Maintain Electronics Eqpt	5	0
Ops. Admin	Postal, Records, Clerical, Admin	2	0
<u>DECK/WEAPONS</u>			
Boatswain Mates	Maintenance of Ship's External Structure, Rigging, Deck Dept; Operate and Maintain Loading/Unloading Equip	67	6

Source: Meraug Study, p. III-6 - III-8.

Table III-1 (Continued)

FUNCTION	DESCRIPTION	LKA	GP CARGO
Fire Control	Maintenance & Repair of Weapons Control Eqpt, Telemetry and Test Eqpt	15	0
Gunnery	Operate and Maintain Guns and Related Gear	7	0
Admin	Clerical/Admin	1	0
<u>ENGINEERING</u>			
Machinery	Maintain and Repair Ships Propulsion Machinery and Auxiliary Eqpt	26	6
Boiler	Operate and Maintain Boilers, Pumps, Blowers	20	3
Electrical	Maintain Power and Lighting, Control Eqpt, Switchboards	15	0
Diesel	Operate, Maintain and Repair Diesel Engines	15	0
Hull	Fabricate, Install and Repair Shipboard Structures, Plumbing and Piping	21	0
Internal Communications	Maintain Interior Communications	6	0
Firemen	Stand Engineering Watch, Perform Minor Repairs	4	3
Admin	Engineering Admin	1	0
<u>SUPPLY</u>			
Disbursing	Maintain Financial Records, Cash	3	1
Storekeepers	Order, Inspect, Stow and Issue Materials and Cargo	8	1
Ship's Service	Operate and Manage Resale Activities, Laundry, Barber, Exchange	8	0

Table III-1 (Continued)

FUNCTION	DESCRIPTION	LKA	GP CARGO
Cooks/Messmen	Operate and Manage Messes	19	5
	<u>MEDICAL</u>		
Medical	Doctors, Corpsmen	8	0
TOTAL		328	40

NOTE 1: There is no precise parallel between the organization of Navy ship and a merchant ship; therefore the table allocates people to job description or function, which is not necessarily identical to actual Navy department and division.

NOTE 2: Almost all personnel on both a Navy ship and a merchant ship do more than one job. The table is based on a typical day of ship's business and does not take into account additional duties of individuals.

Table III-2

COST ESTIMATES FOR MODIFIED MERCHANT SHIPS

	Break- bulk	Ro/Ro	Tri- mariner	LASH	SEABEE	Cargo Pass
<u>Executive</u>	11	11	11	11	11	11
<u>Medical</u>	4	4	4	4	4	4
<u>Navigation</u>	6	6	6	6	6	6
<u>Operations</u>						
(Communications)	18	19	18	19	19	18
(Electronics)	6	6	6	6	6	6
(Intelligence)	11	11	11	11	11	11
<u>Deck/Weapons</u>						
(Cargo handling)	61	29	11	19	11	59
(Boat/Aviation/ Weap) *	31	19	117	79	109	31
(Fire control)	15	15	15	15	15	15
<u>Engineering</u>						
(Engineer) *	34	26	72	54	70	34
(Boiler)	6	6	6	6	6	6
(Electrical)	25	17	21	16	14	24
(Machinist)	14	14	14	13	13	14
(Hull)	24	29	32	30	31	25
<u>Supply</u>						
(Storekeeping)	4	4	9	4	9	4
(Mess)	26	21	34	28	32	26
(Service)	4	5	5	5	5	4
(Disbursing)	1	1	1	1	1	1
TOTAL	301	243	393	327	373	299

* These numbers include crews for the landing craft. In some cases boat crews are furnished by an Assault Craft Unit, in which case they are not technically ship's crew members, but are carried as embarked troops. In either case, however, they require living accommodations.

Source: Meraug Study, p. IV-6.

Table III-3

SUMMARY OF MERCHANT SHIPS SUITABILITY FOR USE
IN THE AFOE OF AMPHIBIOUS OPERATION

	speed	troop capacity	cargo capacity	breakbulk capacity	container capacity	barge capacity	vehicle capacity	self-unloading	more than one unloading system	ability to provide floating dump	ability to deliver cargo already on lighters	ability to carry barge handling facility	large wet-well capability
Cargo/passenger	+	+	o	o	o	-	-	+	+	-	-	-	-
Breakbulk	+	-	+	+	-	-	-	+	+	-	-	-	-
Ro/Ro	+	-	+	-	-	-	+	-	-	-	-	-	-
LASH	+	-	+	+	+	+	+	+	-	+	+	-	-
Seabee	+	-	+	+	+	+	+	+	-	+	+	+	-
Trimariner	-	-	+	+	+	+	+	+	N/A	+	+	-	+
Self-sustaining containership	+	-	+	-	+	-	-	+	+	-	-	-	-
Non-self-sustaining containership	+	-	+	-	+	-	-	-	N/A	-	-	-	-

+ advantage

o limited advantage

- disadvantage

N/A not applicable

IV. CARGO DISCHARGE FROM MERCHANT SHIPS IN AN AMPHIBIOUS OPERATION

A. INTRODUCTION

In World War II, on the beaches of Normandy and in the Pacific, it became clear that we could not build waterfront facilities fast enough to handle ship-to-shore cargo movements during the early stages of an invasion. Twenty years later, in Vietnam, vessels had to wait weeks to discharge their cargoes via inadequate terminals or by over-the-beach methods. Months and sometimes years passed before offloading facilities could be constructed.¹

In an amphibious operation the United States Navy (USN)/United States Marine Corps (USMC) team does not have a great deal of time to offload cargo from assault and follow-on shipping. The success of the operation depends on the rapid offloading of troops, supplies and equipment. The elements of the landing force must be offloaded and moved through the surf, across the beach and inland as efficiently and effectively as possible.

It has already been determined in this study that a sizeable amphibious task force (ATF) depends on the use of merchant ships in the assault follow-on echelon (AFOE). Further, it has been concluded that, with the use of modern day merchant ships in the AFOE, there is a major problem with cargo unloading in the open sea under hostile conditions. These commercial carriers are designed to carry large amounts of

cargo from point-to-point as economically as possible. Modern merchant ships, with the possible exception of barge carriers, rely on sophisticated material handling equipment (MHE) located at port facilities.

Chapter IV will evaluate the methodology and equipment available for the discharge of cargo in an amphibious objective area (AOA). Specifically, two areas of concern will be addressed:

1. the offloading of cargo from ships in the open ocean, and
2. the movement of the cargo over the surf line to the beach.

B. SHIP OFFLOADING

As already pointed out, since the mid-1960's commercial shipping has been steadily shifting toward container ships, Roll on/Roll off (ro/Ro) ships and barge carriers. It is predicted that by 1985 as much as 85 percent of the United States (U.S.) flag sealift capacity will be in container-carrying ships.² The vast majority of these ships will be non-self-sustaining container ships. The offloading of containers from these ships without a conventional port facility presents a problem. Figure IV-1 is an example of the container handling equipment commonly found at major port facilities.

The present cargo handling equipment in the USN is designed for handling pallets (breakbulk cargo). The nature of the equipment does not allow for conversion to a container

offloading capability.³ The solution to this problem requires the timely availability of a container offloading facility in the open ocean of an AOA. Four general concepts for ship offloading will be examined in the study. They are the temporary container discharge facility (TCDF), the crane-on-deck (COD) method, Ro/Ro ship offloading and the airborne method.

1. TCDF

The TCDF is achieved by adding crane(s) of suitable reach to either a ship or a barge anchored alongside a container-carrying vessel. The crane-on-ship method employs a conventional hull which has been reinforced to allow a crane to operate on the deck. If the crane can be quickly installed on selected merchant ships, the result would be a crane-on-ship TCDF. This TCDF would be capable of mooring alongside a container-carrying merchant ship and unloading its cargo into the various types of lighterage* normally found in the AFOE. USN studies have shown that the construction of ships dedicated to serve as container-discharge facilities in time of war would be very expensive. Then once constructed, there would be no peacetime application for a ship of this type. The studies have concluded that the quick installation of cranes for a military contingency is much more cost-effective.⁴ Figure IV-2 illustrates how this installation would be accomplished.

*See glossary of terms.

The cranes must have a capacity of 30 long-tons at an outreach of 112 feet (ft.) and a lift capacity of 52 long-tons at 72 ft. from the ship's side.⁵ This will allow containers to be discharged from ships moored alongside the TCDF directly into lighterage. An added advantage is that containers can be temporarily stored on the TCDF if lighterage is not immediately available.

There are many other advantages to the crane-on-ship TCDF approach:

- a. transporting the TCDF is not a problem. The ship with the crane on board is self-deployable and can cruise at a reasonable rate of speed.
- b. the ship also has some cargo-carrying capacity; although this capacity is significantly reduced by the cranes and necessary accessories.
- c. the ship would have the capability to be a floating repair shop for landing craft. The cranes would have the capability to lift these craft out of the water and onto the deck in order to conduct maintenance.
- d. the ship provides a relatively stable platform for offloading containers in rough seas.⁶

There are disadvantages to the crane-on-ship TCDF approach. There is a very high cost involved for the cranes and accessory equipment.⁷ This equipment would have to be stored in war reserve stocks and maintained for a military contingency. Aside from the storage costs, equipment

obsolescence is a possibility when stored for long periods of time.⁸ Adding to the cost would be the additional crew (e.g., stevedores, maintenance personnel, etc.) that would be required to operate the TCDF. Some estimates are as high as 50 additional personnel.⁹ There is the problem of dedicating a ship for use as a TCDF. This ship could possibly be more beneficial if its purpose was to carry cargo.

The crane-on-ship method was used during the offshore discharge of containerships (OSDOC II) tests conducted by the United States Army (USA) and USMC. The test took place from 3 to 14 October 1972 at Fort Story, Virginia. A USN 1179 class tank landing ship (LST) was used as the crane-carrying ship. A 250-ton mobile crane was utilized on the LST-1179 to transfer containers to lighters.¹⁰ Figure IV-3 is a photo of the actual testing in progress. The operational OSDOC II test of the crane-on-ship TCDF proved to be successful.¹¹

Another form of TCDF is the utilization of a non-propelled barge as the crane platform. During the OSDOC II test, an "A" DeLong barge which is a 150 X 80-foot platform was used as a TCDF.¹² The barge proved to be a very stable platform and the testing was accomplished successfully. The principal disadvantage of the "A" DeLong barge is that it must be towed into the AOA.¹³ The barge is not an ocean-going vessel and is towed at a very slow rate of speed--four to five knots (kn.).¹⁴ In addition to the slow rate of travel,

barges with large cranes mounted on them are not very seaworthy and the equipment incurs prolonged salt-water exposure, considerable motion stress and inadequate maintenance support while in tow.¹⁵ Therefore the towing-transit time and the equipment's condition upon arrival in the AOA create less than a desirable readiness situation.

An alternative to the above method is the use of a "B" DeLong barge. The "B" DeLong barge is a 150 X 60-foot platform. The advantage in using a "B" DeLong barge is that it can be carried on a Seabee-barge vessel. This eliminates the requirement for towing to the AOA. The Seabee is potentially the only ship with the capability of carrying the "B" DeLong barge equipped with a crane of sufficient capacity. The barge was successfully lifted clear of the elevator support pedestals on a Seabee vessel during the Joint Logistics-Over-the-Shore (LOTS) test conducted from 15 to 18 September 1977 in Hampton Roads, Virginia. Although the barge was not completely loaded aboard the Seabee vessel, it was concluded that the capability exists and could be accomplished with minor modifications.¹⁶

The use of a "B" DeLong-barge TCDF causes three major problems:

a. The "B" DeLong barge with a crane aboard is very sensitive to seastate. If sea conditions are other than calm, use of a "B" DeLong barge as a TCDF is hazardous.

b. A 300-ton crane aboard the "B" DeLong barge in the LOTS test could only reach the centerline of the

non-self-sustaining containership; therefore, the barge had to be repositioned on the opposite side of the ship to complete the unloading.

c. There are only three Seabee vessels in the U.S. merchant fleet. Their quick availability in a military contingency cannot be guaranteed.¹⁷

Figure IV-4 shows a barge TCDF unloading containers during the LOTS testing.

Several designs for a future TCDF have been presented by private industry to the Naval Civil Engineering Laboratory (CEL) in Port Hueneme, California. Two proposals are very promising and provide for the evolutionary upgrading of the TCDF concept.¹⁸

One concept submitted by the Eness Corporation and the J.J. Henry Company provides a unique hull design for the crane platform. This concept is shown in figure IV-5. The two hull sections can be joined to form a single hull for more efficient towing. The gantry-type crane is elevated on four posts that are collapsible for efficiency in towing.¹⁹

The Battelle/Western Gear Company's concept employs a ship such as the USN dock landing ship (LSD). The LSD would have a movable kingpost and a traveling barge crane mounted on its deck. The kingpost supports one end of a 225-foot gantry crane and the other end is supported by a self-moving "A" frame structure resting on the deck of the containership.²⁰ This concept is pictured in figure IV-6.

The mechanical complexity and the requirement for space on the containership are disadvantages of the system. The concept, however, displays excellent survivability in rough seas.²¹

Both these revolutionary TCDF concepts can remove 8 X 8 X 20-foot containers at a rate of 20 per hour. This can be accomplished in seastate three which is six-foot waves, eight-foot surf and 30-knot winds.²² The problem with both these systems is that they have a single-purpose mission, that is the unloading of containers from non-self-sustaining containerships. Further they would be expensive to develop and purchase. The possibility of peacetime utilization of these concepts would make them more cost-effective.²³

2. COD Method

The COD method is an expeditious way to make a containership self-sustaining. It involves the addition of a mobile crane to the deck of a non-self-sustaining containership. The crane can move about the ship and discharge the entire cargo by using a portable hatchcover bridging kit. This concept is illustrated in figure IV-7. The LOTS test proved that a mobile crane on the deck of a non-self-sustaining ship could discharge the cargo of the entire ship in the open ocean.²⁴ Figure IV-8 depicts the COD method being employed in the LOTS test.

The preferred crane as determined by the Naval Coastal Systems Laboratory (NCSL), Panama City, Florida, is a 225-ton mobile crane.²⁵ The general characteristics of this crane

are depicted in table IV-1. A crane with this capacity offers two advantages.

a. By placing the crane on the centerline of the containership, it can offload containers to either side of the ship. This eliminates delays incurred while a full lighter clears the ship and an empty one is being moored. While lighters are being exchanged on one side, the crane can shift operations to the other side, where an empty lighter will have already been placed.

b. A 225-ton crane can work hatches on both sides of the ship. This reduces the number of moves required in the discharge of the ship's containers. The net improvement on productivity of this crane as opposed to one of 160-ton capacity is 35 percent.²⁶

In order to spread the weight of the crane to strong points of the ship, a hatch bridging kit is required. The kit consists of two beams, placed parallel to the long axis of the ship. The two beams provide trackage upon which the crane operates. A second set of beams is individually placed in front or behind the crane so it can move forward or aft.²⁷ The basic characteristics of the hatch bridging kit are listed in table IV-2.

Compared to the barge TCDF, the COD is a more stable system. However, the COD method will have problems discharging containers in sea conditions greater than moderate. There are other disadvantages to the COD approach.

a. Depending on the location of each ship's superstructure, three of four cranes could be required per ship.

b. Due to their configuration, there are a number of non-self-sustaining containerships in the U.S. merchant fleet that make it impossible for COD operations.

c. Crane availability is a problem. The services would have to buy or lease a number of the 225-ton cranes. This number can be quite large when considering that each non-self-sustaining containership arriving in an AOA would have its own cranes. Therefore, the concept is an expensive one.

d. As a result of each non-self-sustaining containership having cranes on its decks, approximately ten percent of the cargo capacity of the ship is lost.²⁸

Despite the disadvantages listed, the COD method is a workable alternative to the container discharge problem. Implementation is a matter of procuring assets.

It can be concluded that the COD and TCDF ship off-loading methods are viable solutions to the discharge of containers from non-self-sustaining containerships. Further, there are some novel concepts proposed by industry for solving the container discharge problem. However, shortcomings with TCDF and COD do exist. These include seastate sensitivity, cost, mobility to the AOA, single purpose use and reduced cargo capacity. The requirement exists for more testing and further development of present methods.

3. Ro/Ro Ship Offloading

As pointed out in this study, the Ro/Ro has the capability of transporting large numbers of heavy vehicles, including 60-ton tanks, to the AOA. Therefore, it has the potential of being an optimum support vessel to the Navy and the Marine Corps in amphibious operations. This potential cannot be realized unless methods for offloading Ro/Ro ships in the open ocean are devised. CEL is involved in the development of Ro/Ro offloading methods. Three of these methods (the low seastate ramp, the Ro/Ro lift device and the high seastate ramp) will be addressed in this section. Two of the three methods, the low seastate ramp and Ro/Ro lift device, are expected to be operational in fiscal year (FY) 1982.

The emphasis of the unloading-development effort at CEL is toward the Ponce/Lurline class, the Great Land class and the Maine class Ro/Ro ships. All of these were addressed in Chapter III of this study. The Defiance class accounts for only 4.1 percent of the total Ro/Ro parking space available in the U.S. merchant fleet and it is primarily operated as a containership; therefore, it is eliminated from consideration in this study.²⁹ Table IV-3 depicts the U.S. flag Ro/Ro's and parking areas. Table IV-4 lists the characteristics of the three classes of Ro/Ro's being considered.

In order to evaluate the offloading of vehicles in the AOA of an amphibious operation, it is necessary to look at vehicle limitations and types of military vehicles that

will be carried aboard a commercial Ro/Ro. The vehicle limitations are summarized in table IV-5. The major limitation when offloading vehicles onto a ramp is the breakover angle, i.e., the angle formed by the ramp and ship. The sharpest breakover angle when unloading vehicles from the ship to a low platform via a ramp is with the side ports of the Ponce/Lurline and Great Land class Ro/Ro ship. Consideration must be given to vehicles with low breakover-angle limits when planning loading and unloading of a Ro/Ro ship.

Maneuverability of the vehicle is also a prime consideration. Ro/Ro ships are designed to carry 40-foot trailers. Those trailers are unloaded commercially by the use of a short maneuverable yard tractor. These tractors are not available in the military inventories, therefore, maneuverability of vehicles in unloading can be a significant problem.

More common vehicles that are contained in the USMC landing force are 6 X 6-foot, five-ton cargo or dump trucks with two-wheel trailer, one-quarter-ton jeep with trailer and five-ton truck tractor with a van or 12-ton high bed trailer. The van or high bed trailer is expected to present the most difficulty in unloading because of its relative lack of maneuverability. The trailer can carry an 8 X 8 X 20-foot container, consequently making it a very critical item of equipment in the AOA. The five-ton truck tractor

with 12-ton high bed trailer loaded with an 8 X 8 X 20-foot container is very similar to a standard truck/semi-trailer loaded with a commercial container.

Table IV-6 lists the vehicles found in the USMC landing force that approach the limits set forth in table IV-5. In a simulated test, conducted by CEL using the Ponce/Lurline class Ro/Ro, maneuvering problems emerged as the most significant.³⁰ The turning radius of the vehicles was a limiting factor in the efficient unloading process. Cornering the multitude of columns when trying to gain access to the side ports was the biggest problem. When maneuvering space is restricted, the skill of the driver will effect the offloading rate. Also the offloading rate is expected to degrade as the seastate increases. This is caused by the motion of the ship and the offloading facility.

Three ofloading concepts being developed by CEL will be addressed in this section. They are the low seastate ramp, the Ro/Ro lift device and the high seastate Ro/Ro lift device. The low seastate ramp is derived from the use of bridge sections currently being held or forthcoming into the Army's inventory. Figure IV-9 illustrates this concept. The bridge section is used as a ramp from the stern or side port of a Ro/Ro to a floating causeway section. Three of the Army's basic bridge types are being considered. They are the armored vehicle launched bridge (M60AVLB), the Bailey bridge and the medium girder bridge.³¹ The low seastate ramp can only be

used in a very calm, harbor-like sea condition. This is a severely limiting factor for use in an amphibious environment. A calm seastate cannot be counted on in an AOA.

In a slightly higher seastate, the Ro/Ro lifting device presents another alternative. The TCDF already discussed would be configured with a special Ro/Ro lifting cage pictured in figure IV-10. The cage would be configured to allow a Ro/Ro capability. This device would also be very sensitive to seastate and the unloading rate would be slow.

A third conceptual design approach to offloading vehicles from a Ro/Ro ship is the high seastate ramp. This ramp is pictured in figure IV-11. This would involve the use of a specially designed and manufactured ramp leading to a causeway section. This alternative would require higher development and manufacturing costs than the other alternatives.³² The causeway section could be self-propelled allowing movement from ship-to-shore with the vehicles aboard. The self-propelled causeway will be discussed in detail in the ship-to-shore section of this chapter. The high seastate ramp can be used in seastate 3 but the low seastate ramp is limited to use in a seastate 1 and the Ro/Ro lift device is limited to use in seastate 2.³³

It can be concluded that although none of the above described systems are functioning, they do offer some viable solutions to the Ro/Ro problem in the not-so-distant future. Their major shortcoming is their sensitivity to seastate.

4. Airborne-Unloading Systems

The TCDF and COD methods of container unloading from ships depend on lighterage for the ship-to-shore movement of containers. A big advantage of the airborne system of ship unloading is that containers can be unloaded from the ship and moved directly to the beach or for that matter further inland to the user.

A number of airborne systems have been developed for container offloading in the AOA. Under consideration for airborne delivery of containers are the balloon-transport system, the aerocrane, the helistat and the helicopter.

a. Balloon-Transport System

In World War I, numerous bombing, observation and supply missions were accomplished by using balloon technology. The airship was used extensively in World War II in an anti-submarine role. Following World War II, there were 168 airships in the inventory; however, they gradually became obsolete as a tactical vehicle. In 1961, the remaining fleet of airships were decommissioned.³⁴

In recent years, studies have been done to explore the possible use of lighter-than-air vehicles in logistical operations. Of particular interest to this study have been the efforts to employ these vehicles to move heavy cargo such as containers.

The lighter-than-air balloon has been in use for many years in the Oregon logging industry. The balloon system

has allowed timber to be removed from remote logging sites without having to build expensive road networks. Due to the balloon's heavy lift capability and its success in the logging industry, the USA and USN designed a series of tests to determine if the balloon concept could be applied to military logistics. Of particular interest was the possibility of using balloons to transfer containers from ship-to-shore and to transfer containers from ship-to-lighter. The balloon-transfer test was conducted at Fort Story, Virginia, in March of 1977. An LST 1180 was used to simulate a containership.³⁵

In the ship-to-shore unloading, pictured in figure IV-12, it was concluded that the balloon system was technically feasible; however, operational problems were encountered:

(1) the load pendulation* made container handling difficult and hazardous on the deck of the ship.

(2) the unloading operation was very sensitive to wind conditions.³⁶

In ship-to-lighter unloading, testing proved this method less promising. In addition to wind sensitivity and pendulation problems, mooring the ship within the tolerance required by the balloon system and lighters proved to be difficult and time-consuming.

*See glossary of terms.

Despite the problems, the test group concluded that the concept had promise and efforts to overcome the problems should be pursued. However, at this time there has been no further action taken. CEL engineers are pessimistic about the future of this concept, primarily because of its sensitivity to wind.³⁷

b. Helistat and Aerocrane, Advanced Concepts

The helistat (quadrotor) is a buoyant air vehicle which employs four large helicopters rigidly attached to an interconnecting structure. This concept is shown in figure IV-13. The controls on the helicopters are interconnected. A helium-filled envelope attached to the interconnecting structure provides buoyance to the entire assembly. This concept gives the helicopter ten times its normal load capacity.³⁸ The interconnected control systems respond to one set of controls in the aft port helicopter which is designed as the master control station. The payload is carried externally, slung below the vehicle on four cables.

The aerocrane (roto balloon) is an air vehicle which combines the aerostate-lift force of the balloon with the aerodynamic-lift force of a helicopter. This concept is illustrated in figure IV-14 and figure IV-15. The aerocrane weighs 50 tons and has four 112 X 18-foot wings. Each wing would have a 200-horsepower, turboprop engine mounted to it.³⁹ The low pressure sphere provides an aerostatic lift equal to all of the vehicle's structural weight. The four

wings provide the remaining ship-load lift and the force required for vehicle movement at ten revolutions per minute. In flight, the balloon and wings rotate as the vehicle moves through the air. The control cab underneath is powered and geared to rotate at the same speed and in the opposite rotation to the aircraft structure; therefore, the cab maintains a still position relative to the buoyant air vehicle.

The helistat and the aerocrane are concepts that were developed by the Naval Air Systems Command (NAVAIR). The development was motivated by the need to lift the heavy standardized containers that will be found in the amphibious environment of the future. The aerocrane and helistat are considered high risk-development projects. They have potential for meeting short haul, heavy lift, operational requirements. Considerably more testing is required before a judgment can be made as to their ultimate feasibility and utility. Cost and transportability are serious considerations bearing on these two advance development projects. In the final analysis, sensitivity to wind conditions will probably be the eliminating factor since inflating the air system cannot be accomplished in wind conditions higher than eight kn.⁴⁰

c. Helicopter Unloading System

There are a number of advantages to using a helicopter for container offloading in the AOA. They are as follows:

(1) it eliminates the need for watercraft and heavy lift capability on the beach.

(2) it can be used to deliver containers directly from the ship to the logistic support area (LSA).

(3) the tactical situation permitting, it can be used to deliver containers further inland to the user (this would be ideal in the case of containerized ammunition).

(4) it is insensitive to sea conditions.⁴¹
Container offloading by helicopter is pictured in figure IV-16.

There has been considerable testing using USMC CH-53 and CH-47 helicopters. The CH-53 can be modified to handle a 16-ton container and the CH-47 can be modified to handle 12 tons.⁴² The standard 8 X 8 X 20-foot container, fully loaded, weighs approximately 22 tons; therefore, any container requiring helicopter lift would have to be weight limited. Further, the hatch covers on non-self-sustaining containerships which weigh 25 to 35 tons would have to be removed by some external source such as a TCDF or COD.⁴³

The primary use of the USMC helicopter is combat support. Assigning helicopters for logistical unloading of containers while there is a tactical situation ashore is unlikely unless there is a significant increase in the number of helicopters normally assigned to a Marine amphibious force (MAF). Considering the high cost of helicopters and today's fiscal constraints, this is unlikely.

The USA was developing a heavy lift helicopter (HLH) that was to be used for the discharge of 8 X 8 X 20-foot containers from container ships. The HLH would have had a 23.5-ton lift capacity.⁴⁴ However, the development effort was stopped due to high research and development costs and the high estimated unit costs. The HLH would also have had a problem with the heavy hatch covers.

It can be concluded that the USMC CH-53 pictured in figure IV-16 can be very useful in unloading high-priority, weight-limited, deck-stowed containers; however, helicopter availability in a tactical situation is expected to be limited.

C. SHIP-TO-SHORE MOVEMENT OF CARGO

Thus far in Chapter IV various methods of offloading non-self-sustaining container ships and Ro/Ro ships have been examined. In the case of airborne systems, the cargo can be delivered directly to the beach or even further inland; however, when unloading is accomplished by the TCDF, COD and Ro/Ro methods, the cargo must still be transported through the surf to the beach before being unloaded. Generally, this involves the use of lighters. In the case of a heavy 22-ton container, this is no easy task when obstacles such as heavy surf, bad weather and soft sand are possible. This section of Chapter IV will address methods of solving the ship-to-shore movement of cargo.

1. Elevated Causeway

The elevated causeway system developed by CEL has potential for solving the ship-to-shore offloading problem for containers and rolling stock transported on commercial ships.

The elevated causeway system is designed to provide an interface between the lighterage and beach by bridging the surf zone.⁴⁵ The elevated access terminates at the offshore end in a pierhead that supports the cargo unloading function. Figure IV-17 illustrates the pierhead arrangement. The system is based on a 3 X 15-foot pontoon section, 21 ft. wide by 90 ft. long.⁴⁶ The pontoon sections make up the floating causeway which is part of the equipment maintained by the USN amphibious construction battalion. The major elements of the system are an elevating capability for the existing floating causeway, a crane installed at the pierhead of offloading lighters, a fendering system allowing the mooring of lighters to the pierhead for offloading, a turnaround component to redirect truck traffic on the causeway (within a limited area) and a two-way traffic access from the pierhead to the beach.

a. Elevating Capability

The elevating system consists of five hydraulic chain jacks and accessory equipment.⁴⁷ Once elevated, the causeway is supported by 20-inch piles. The elevating system can be packaged in an 8 X 8 X 20-foot container. Figure IV-18 shows the elevating process taking place.

b. Crane

In tests* conducted on the elevated causeway, a 90-ton, truck-mounted, rubber-tired crane was used. The crane is pictured in figure IV-19. The function of the crane is to offload containers from lighters moored alongside the pierhead and place them on the back of semi-trailers. The crane is adapted with a container-handling spreader such as the one pictured in figure IV-20.

c. Fender System

A system consisting of plastic fenders is used to cushion the lighterage during the loading and unloading process. The cushions are four ft. in diameter and 7.4 ft. in length.⁴⁸ Figure IV-21 shows the system in the process of being installed.

d. Turnaround System

A turntable is utilized to rotate trucks and trailers at the pierhead area. The turntable rotates on eight 34-inch in diameter air bearings, is 48 ft. long and has a total weight of 30,000 pounds (lb.). Figure IV-22 shows a USMC M52 truck with an M127 trailer (M52/M127) being rotated on the turntable. This system eliminates the necessity to build a large pierhead in order to have sufficient area for trucks to turnaround. The USMC M52/M127

* Two tests in constructing and utilizing the elevated causeway have been accomplished: one at Point Magu, Ca., in July 1975, and the other at Coronado, Ca., in January 1976.

would require an area equivalent to eight causeway sections in order to turn around at the pierhead area.⁴⁹ This vehicle can be used to carry the standard 8 X 8 X 20-foot container.

e. Two-Way Traffic

The elevated roadway from the beach to the pierhead allows two-way traffic. The roadway meets the specifications of an H20 highway, i.e., a 32,000 pound axle load and 75-pound per square inch (psi) wheel pressure.⁵⁰ Two-way traffic on the causeway is pictured in figure IV-23.

f. Performance Goals

The elevated causeway was designed and developed to meet or exceed the following requirements:

- (1) compatible with lighterage for offloading existing containerships and other container-capable ships such as Ro/Ro ships, bargeships and other cargo ships
- (2) transportable by amphibious force ships and commercial shipping
- (3) provide for lighterage operation/cargo handling and unloading beyond the surf zone
- (4) capable of being elevated from the floating mode with an installation time of 72 working hours for a 12-section pier
- (5) capable of handling 20-foot (22-ton) containers with provision for future handling of 40-foot (35-ton) containers

(6) capable of being elevated 15 ft. above mean low water (to account for 8-foot tide), in water depths of ten to 20 ft. at the pierhead

(7) capable of providing for a transfer rate of ten to 20 containers per hour from lighterage to shore (assuming sufficient lighterage)

(8) capable of operating continuously for a period of six to 12 months, after which time it can be incorporated into a larger installation, relocated, or retrieved and stored.⁵¹

It was concluded, based on two tests conducted thus far, that the elevated causeway can be used for transferring 8 X 8 X 20-foot containers weighing up to 22 tons to the beach. However, CEL has several recommendations relative to the equipment and installation techniques that would significantly improve the system.⁵² It is the opinion of CEL engineers that if these recommendations are implemented, the elevated causeway can meet the performance goals listed.⁵³

2. Self-Powered Causeway System

CEL is developing a self-powered causeway section. The concept involves a standard 3 X 15-foot causeway with a self-contained propulsion capability. The powered causeway is made up of two subsections: a non-powered subsection and a waterjet propulsion plant.

The self-powered causeway system was designed to meet the following major operational requirements:

- a. deployment by LST side-carry, relieving valuable LSD wet-well space
- b. self-sustaining powered causeway ferry operations
- c. minimum degradation in thrust and maneuverability when operating in surf zone and in debris-infested waters.⁵⁴

The self-propelled causeway can perform three functions. In the first, as a powered causeway ferry, it acts as a vehicle for transporting cargo from a ship to an unloading station such as the elevated pierhead. This function is pictured in figure IV-24. Second, as a self-propelled causeway, vehicles can be unloaded from a Ro/Ro ship onto the causeway. The causeway can then be powered into the beach where the vehicles can be offloaded. This function is pictured in figure IV-25. Third, as a warping tug, it simulates a barge capable of carrying cargo. This function is pictured in figure IV-26.

Prototype testing of the self-propelled causeway section in 1977 proved that it could be a very valuable piece of equipment when used to solve the movement of containers and vehicles from commercial shipping to the shore in the AFOE of an amphibious landing. Figure IV-27 depicts the operational characteristics of the powered causeway section.

3. Landing Craft Air Cushion (LCAC) Vehicles

The LCAC vehicle, JEFF B, discussed in Chapter III, has great potential for use in the ship-to-shore movement of containers. An LCAC vehicle has the capability to "fly"

through the water at speeds up to 50 kn. It can go over the surf line and onto the beach. While on the beach, it can proceed at a reduced rate of speed, approximately five miles per hour (mph), to an unloading circle. The LCAC can maneuver into position, drop from the air cushion, and lower its two ramps. Container handling equipment can then commence unloading.⁵⁵ The characteristics of the JEFF B are shown in figure IV-28.

Table IV-7 shows the maximum number of containers transportable by the JEFF B.

Table IV-8 is provided to give the dimensions and weight of each container listed. The computation assumes a single tier container. The 8 X 8 X 20-foot containers and larger ones will impose high concentrated loads on landing craft decks, since all the load is transferred through the four end fittings (points). For an 8 X 8 X 20-foot container, the maximum point load is 11,200 lb. or 456 psi. The corresponding load for the 8 X 8 X 40-foot container is 16,800 lb. or 628 psi. Large base plates would have to be utilized on the decks of the craft to distribute the high corner loads over a greater area.⁵⁴

Cargo damage while at sea due to the container being only partially loaded has been reported. This problem would be aggravated in ship-to-shore movement in a LCAC vehicle; consequently, greater attention to internal packing would be required and possibly special tie-down fittings could be used in the LCAC vehicle.⁵⁵

Since the LCAC vehicle is not scheduled to enter the Navy until 1985, its usefulness in container transport for ship-to-shore movement is speculative at this point.⁵⁸ Further, use of the LCAC highlights another problem, i.e., the offloading of containers from a landing craft on the beach. As already pointed out, commercial containers are normally offloaded by sophisticated equipment at the pier facilities. Currently, there is no MHE in the USMC's inventory that can satisfactorily unload a container weighing in excess of 20 tons from a landing craft on a sandy beach.

4. Light Amphibious Container Handler (LACH)

A solution to the problem of container unloading could be with the LACH. The LACH is pictured being utilized in beach operation in figure IV-29. The responsibility for developing the LACH lies with the USMC. This experimental vehicle is designed to remove fully-loaded containers from landing craft that have been beached. Its lift capacity is 50,000 lb.⁵⁹ The LACH can be pushed or towed by a bulldozer with the blade removed. In the LOTS test conducted in 1977, the LACH prototype performed well in its designed mission to straddle a standard 8 X 8 X 20-foot container and lift it well off the surface. It can straddle any standard truck bed up to eight ft. wide and lower the container onto the truck.⁶⁰

Some of the characteristics that make the LACH a good candidate for use in an amphibious environment are:

a. it extends the usefulness of conventional landing craft by bridging the shoreline gap caused by receding tides on a shallow-slope beach.

b. it has large wheels (approximately eight ft. in diameter) which allow it to traverse shallow shoreline water in retrieving cargo.

c. it is compatible with all landing craft currently in the Navy's inventory.

d. it could be modified to pick up breakbulk cargo as well as containers with only a small development effort.

e. it is relatively easy to maintain. Electrical and hydraulic systems are self-contained and comparatively easy to perform both preventive and corrective maintenance.

f. its weight is only 40,000 lb., making it easy to transport. Its lift capacity is more than its own weight.

g. its cost, \$50,000, is relatively cheap when considering the function that it performs.⁶¹

Two distinct disadvantages that are characteristic of the LACH are:

a. its reliance on a prime mover such as bulldozer which may not always be available

b. its slow cycle time (it can unload four containers per hour from a lighter at the shoreline and place them on a truck for transportation inland).⁶²

With the projected use of the LCAC vehicles in 1985, the LACH provides tremendous potential for container unloading

on the beach. This would be a major development in the efficient and effective ship-to-shore movement of standard 8 X 8 X 20-foot containers.

D. CONCLUSION

If the U.S. had to conduct an amphibious operation today, requiring the use of non-self-sustaining containerships and containerized cargo, there would be no way to unload and move cargo ashore. The same can be said for Ro/Ro ships with their cargo of combat vehicles.

It can be concluded from the contents of this chapter that many innovative concepts that offer solutions to various stages of the cargo discharge problem are available. Some of these concepts have been completely developed and others are nearing completion; however, none of them have been fully implemented as of this date. The equipment required has not made its way into the inventories of the appropriate military services. Primarily, this is due to fiscal constraints: not only the lack of money to purchase equipment, but also lack of funding to speed development efforts.⁶³ Table IV-9 depicts the completion or estimated completion dates of the development of the discharge concepts discussed.

All of the concepts have certain advantages and disadvantages. These are summarized in tables IV-10, IV-11 and IV-12. Based on recent information, the lighter-than-air concepts (balloons, helistat and aerocrane) have been eliminated from

further development at this time. This is due to their extreme sensitivity to wind conditions.

Although some methods have more advantages than others, the intent is not to prove one method better than another. Advantages and disadvantages are weighed differently. Further, it might take a complement of most of the methods available to conduct ship offloading and cargo movement to shore in a major amphibious operation. Availability of various types of shipping, cranes, landing craft, helicopters, beach unloading devices and other equipment will dictate the types of methods used.



Figure IV-1. Commercial Pier Facility Container Handling Equipment

Source: Marine Engineering/Log, p. 57.

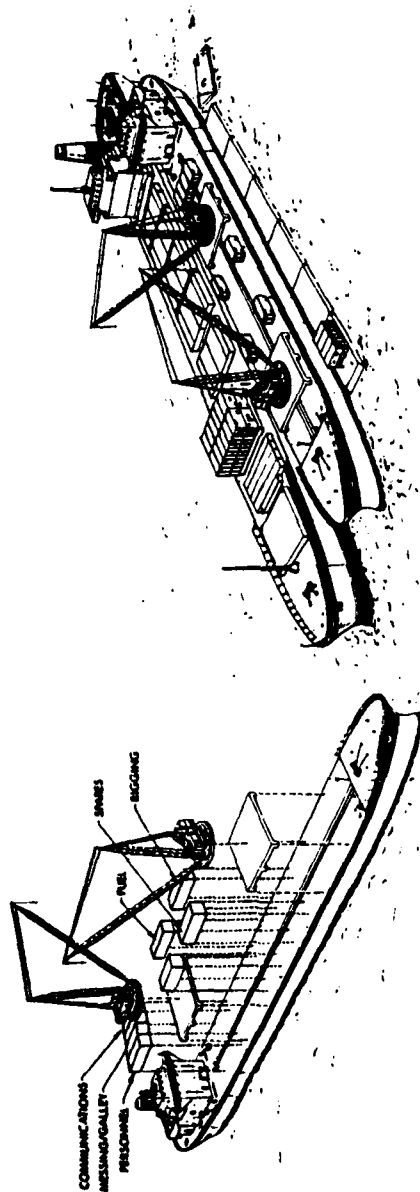


Figure IV-2. Temporary Container Discharge Facility (TCDF)

Source: (COTS) Container Offloading and Transfer System, p. 7.

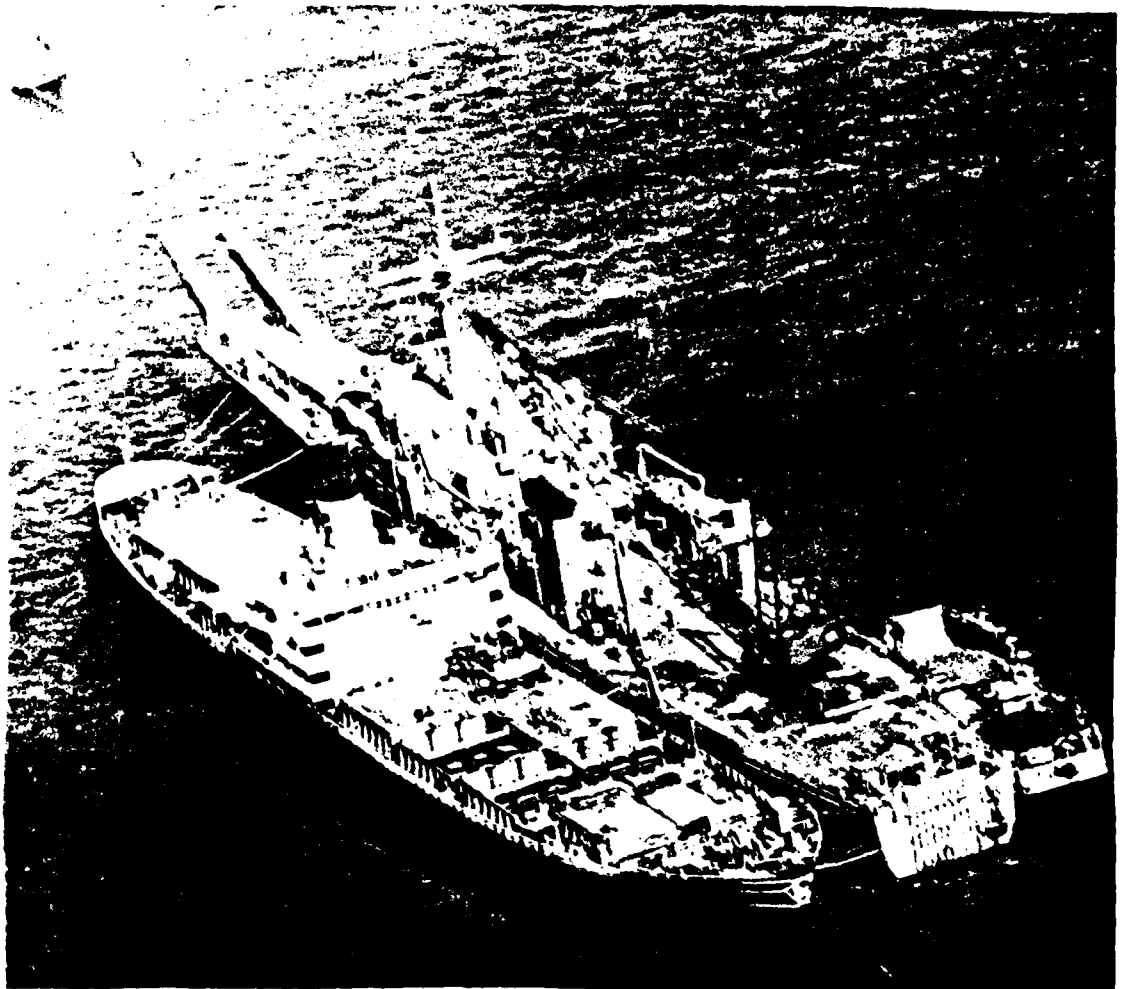


Figure IV-3. USN 1179 Class LST Serving as TCDF

Source: (COTS) Container Offloading and Transfer System, p. 5.

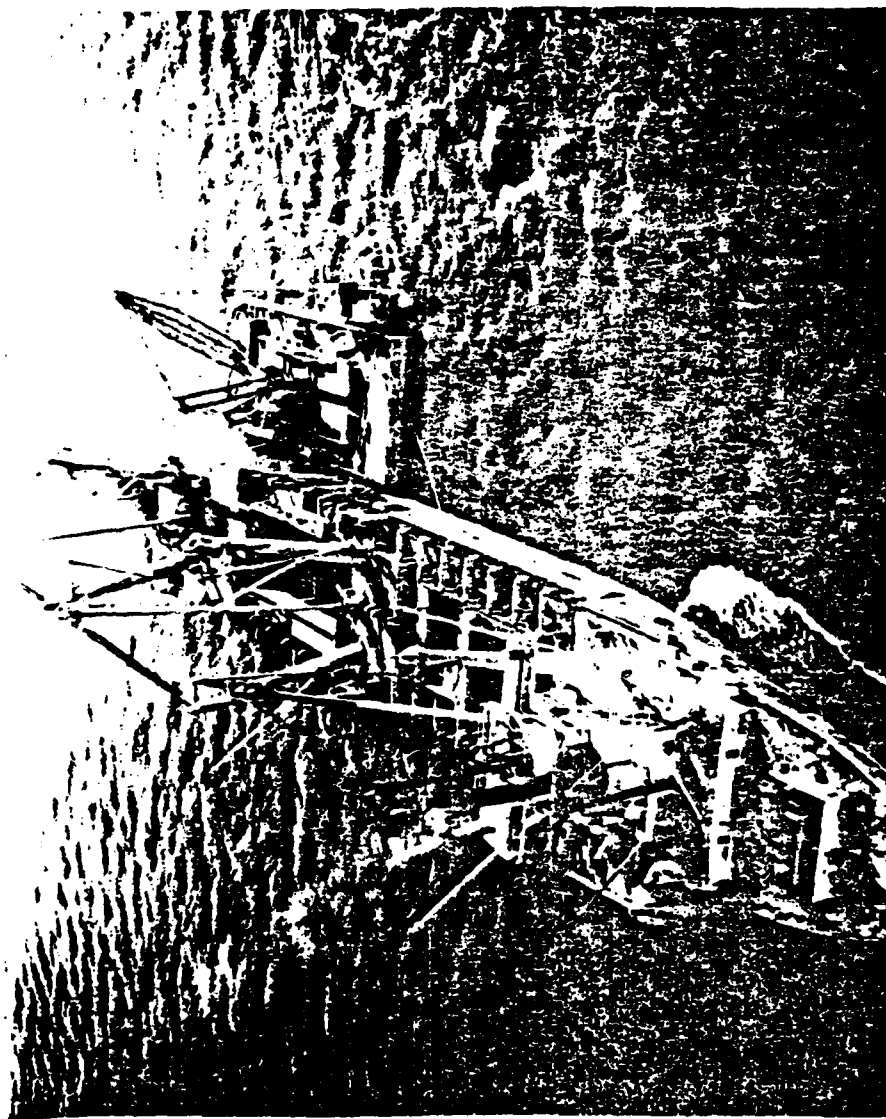


Figure IV-4. Barge TCDF Unloading Containers

Source: Heavy-Lift Breakbulk Ship Pretest Results of the Joint Logistics-Over-the-Shore (LOTS) Test and Evaluation Program, p. D-36.

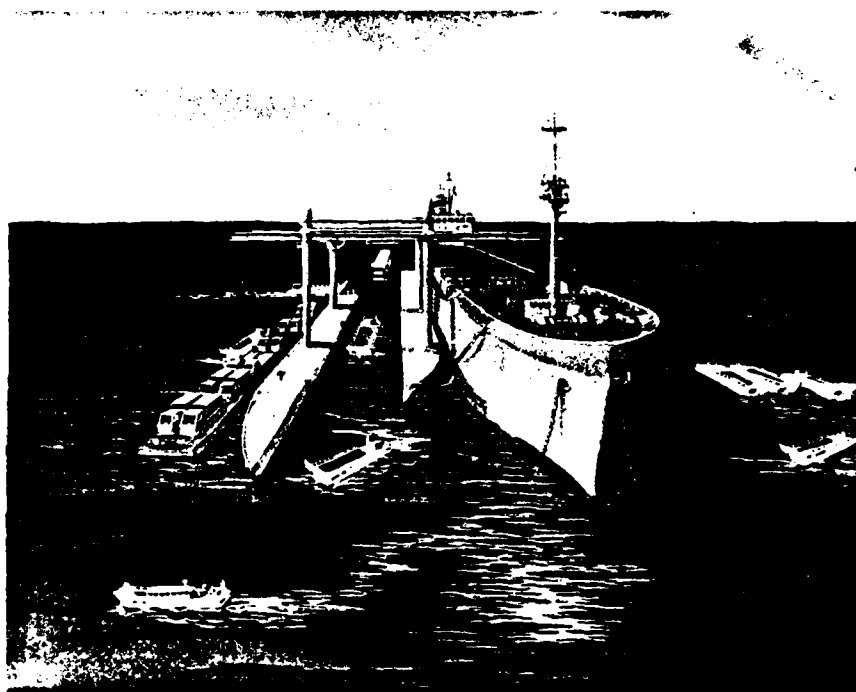


Figure IV-5. Eness Corporation and J.J. Henry
Company Concept

Source: Project ELF, Expeditionary Logistics
Facility for Containerships, Barge
Ships and Other Cargo Ships, p. 14

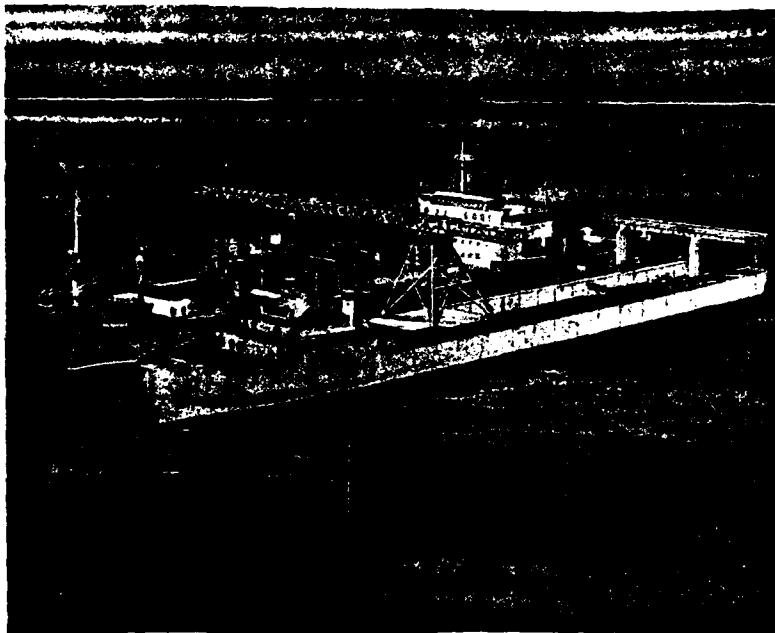


Figure IV-6. Battelle/Western Gear Company's Concept

Source: Project ELF, Expeditionary Logistics Facility
for Containerships, Barge Ships and Other
Cargo Ships, p. 15.

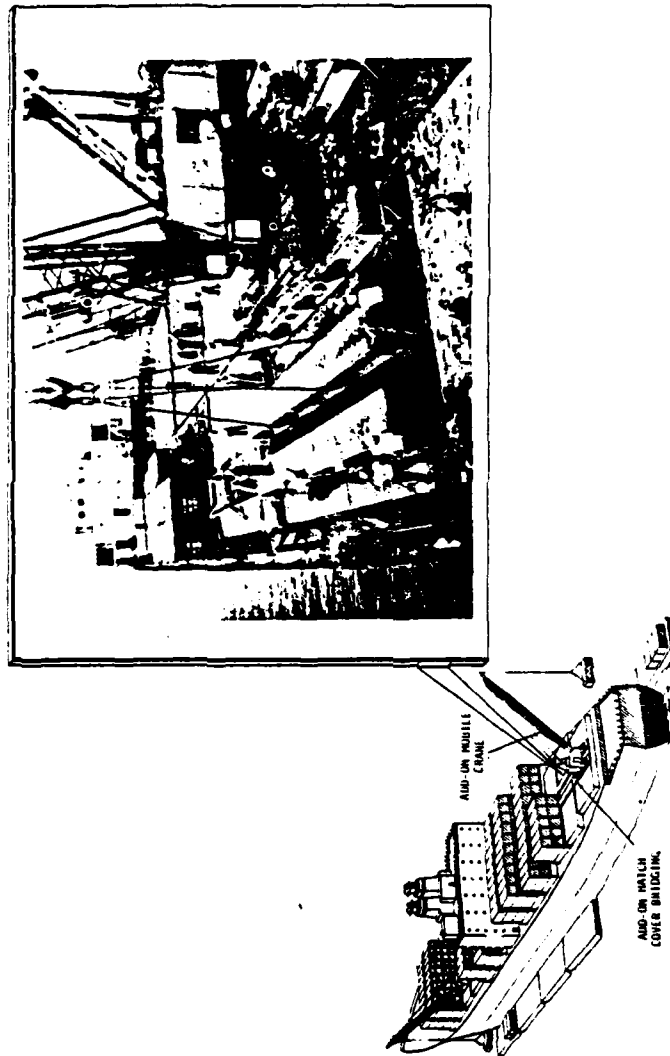


Figure IV-7. Crane-on-Deck (COD)

Source: (COTS) Container Offloading and Transfer System, p. 9.

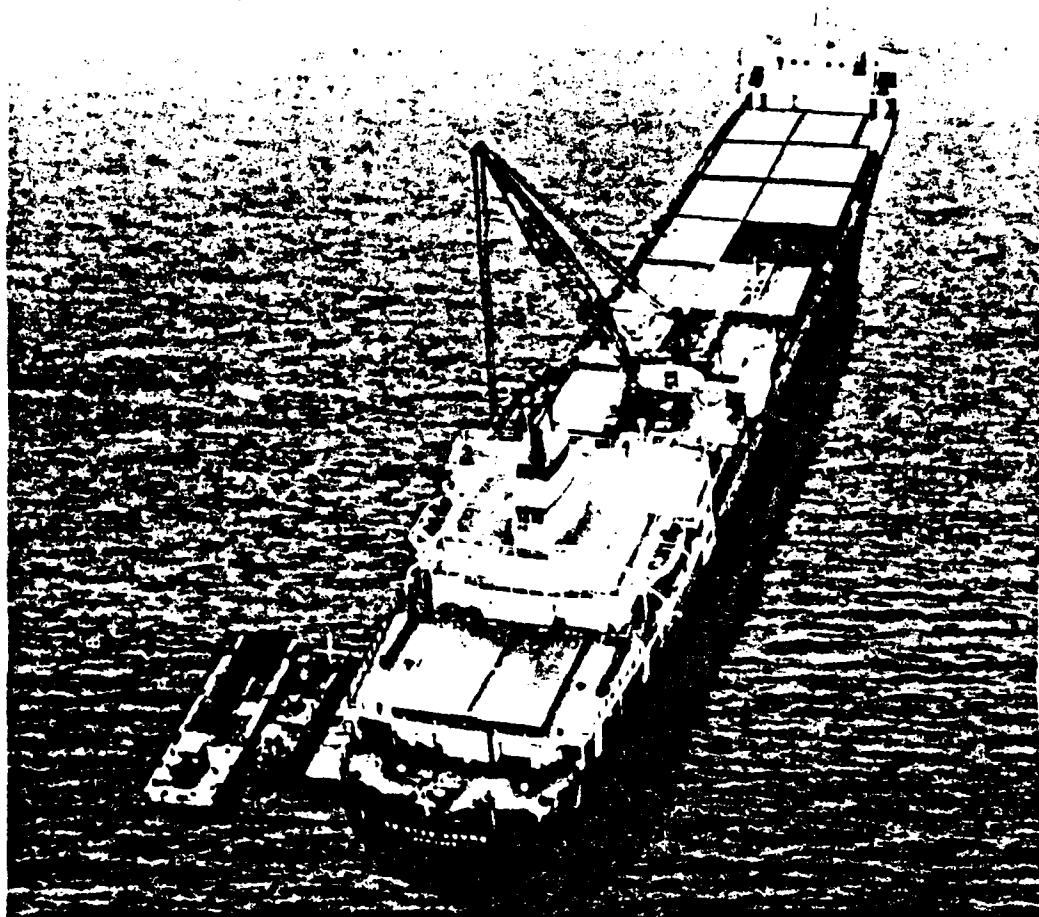


Figure IV-8. COD Method Being Employed in LOTS Test

Source: (COTS) Container Offloading and Transfer System, p. 8.

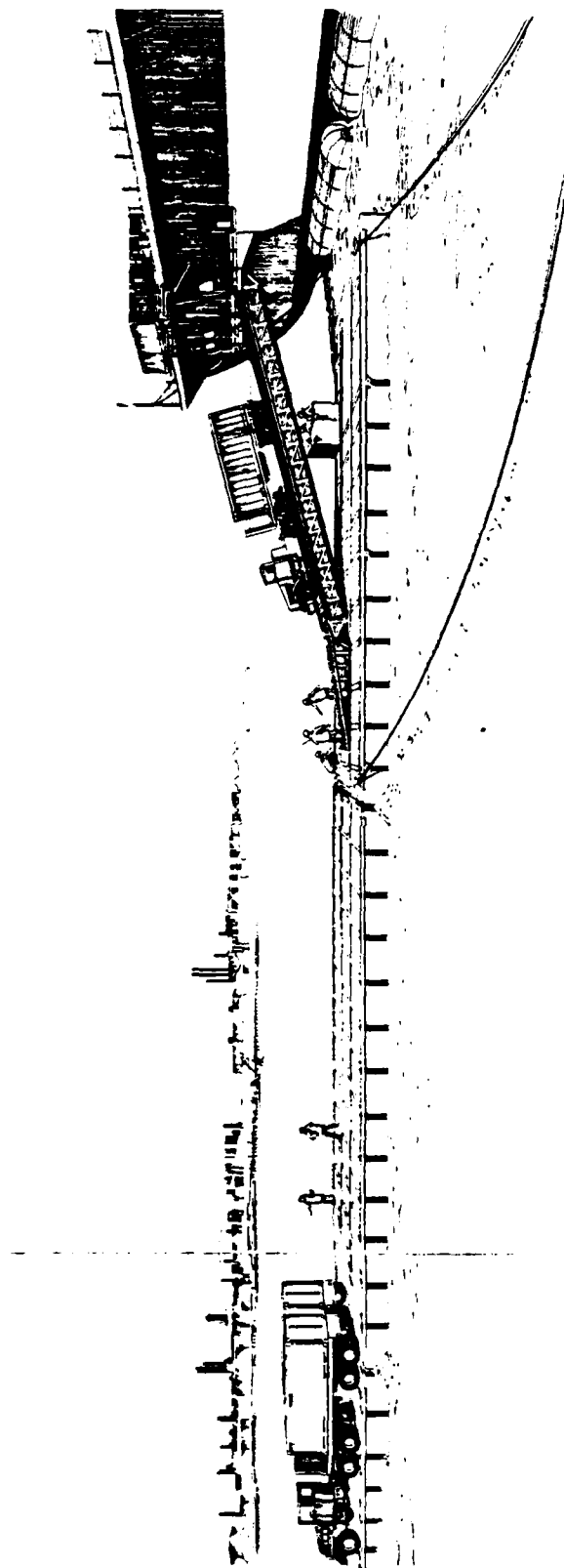


Figure IV-9. Ro/Ro Low Seastate Ramp

Source: Ro/Ro Linking up to the Military, p. 20.

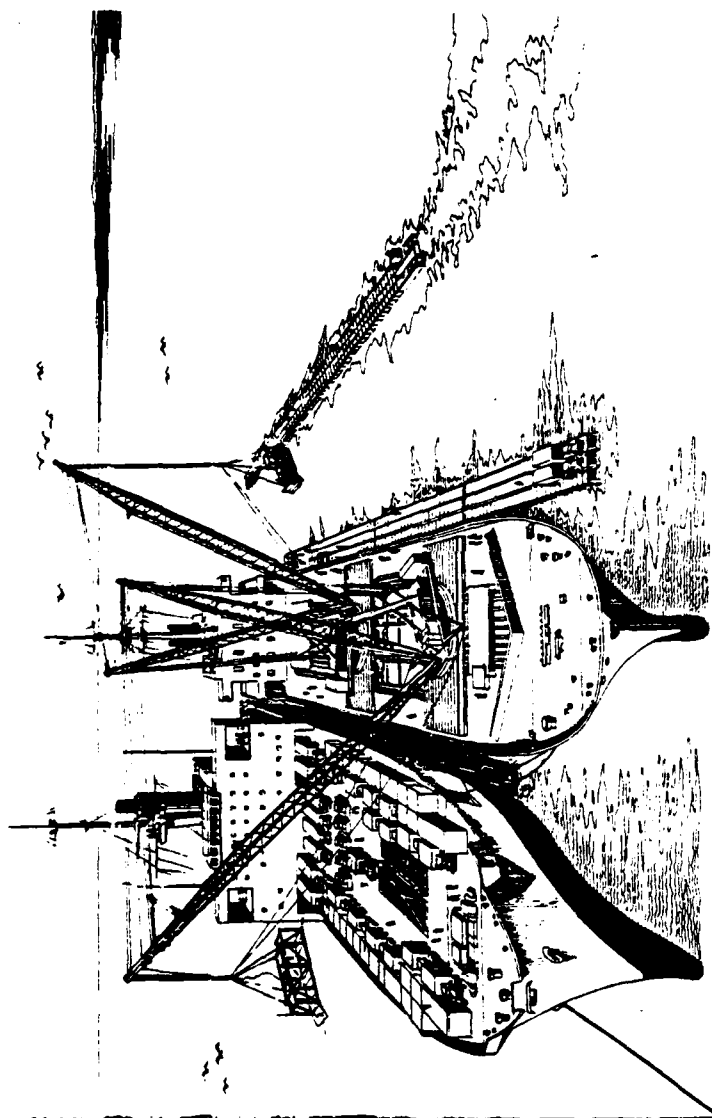


Figure IV-10. Ro/Ro Lift Device

Source: Ro/Ro Linking up to the Military, p. 21.

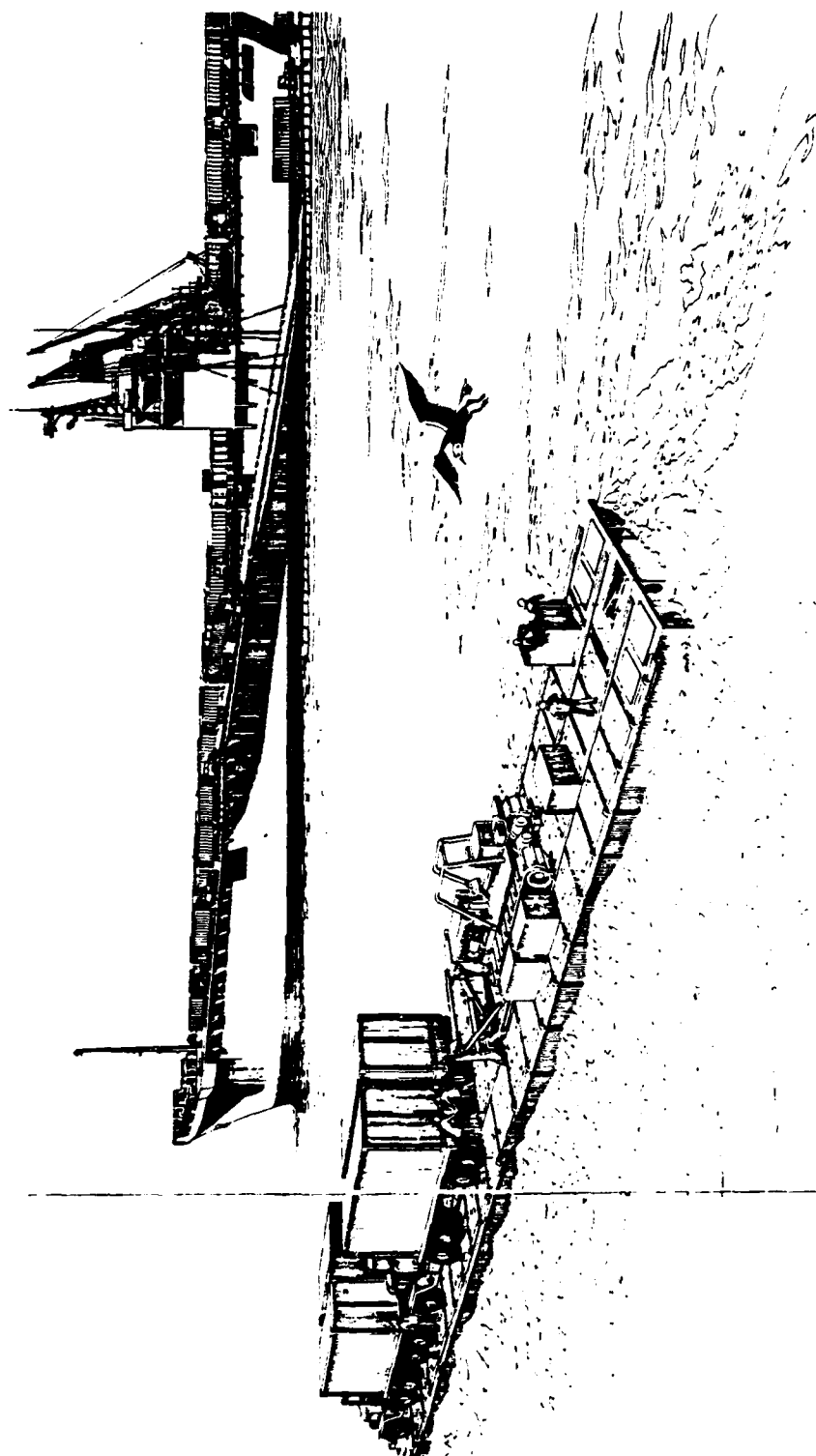


Figure IV-11. Ro/Ro High Seastate Ramp

Source: Ro/Ro Linking Up to the Military, p. 16

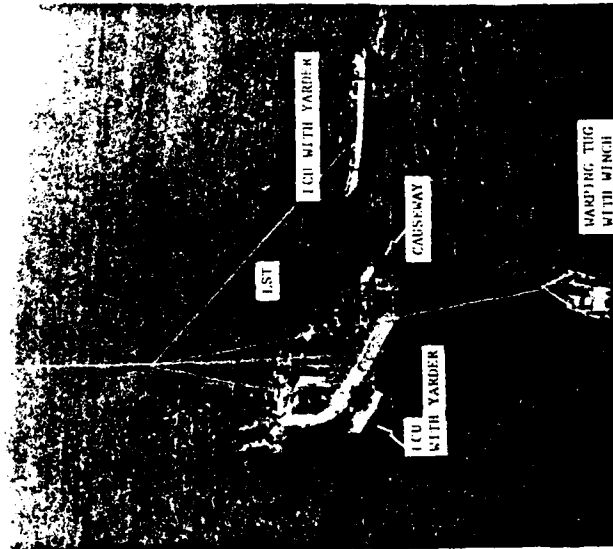
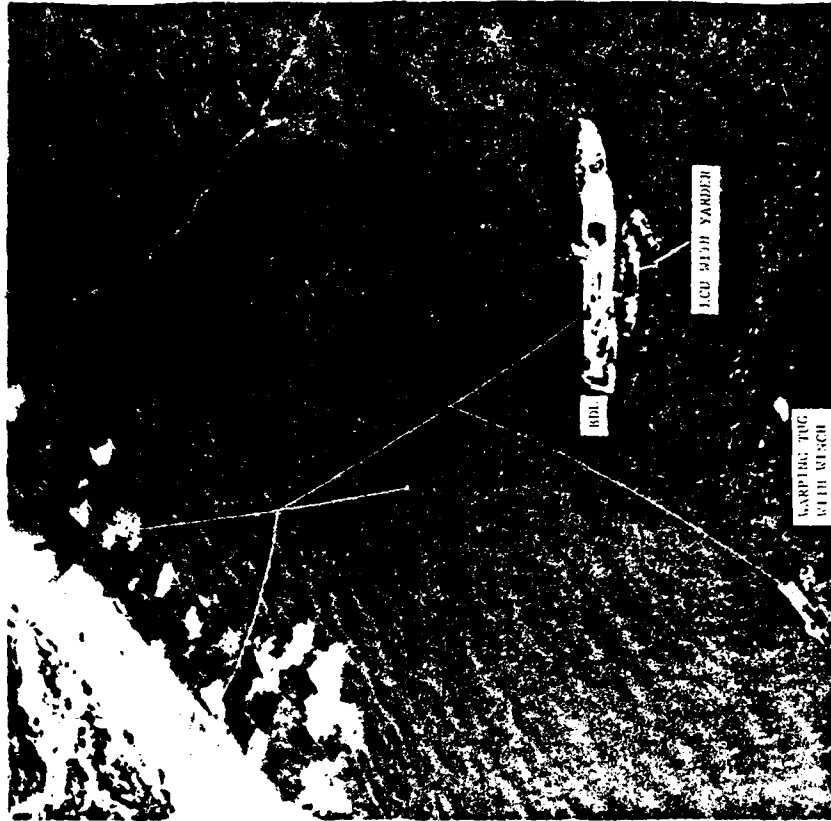


Figure IV-12. Balloon Transport System

Source: (COTS) Container Offloading and Transfer System, p. 13

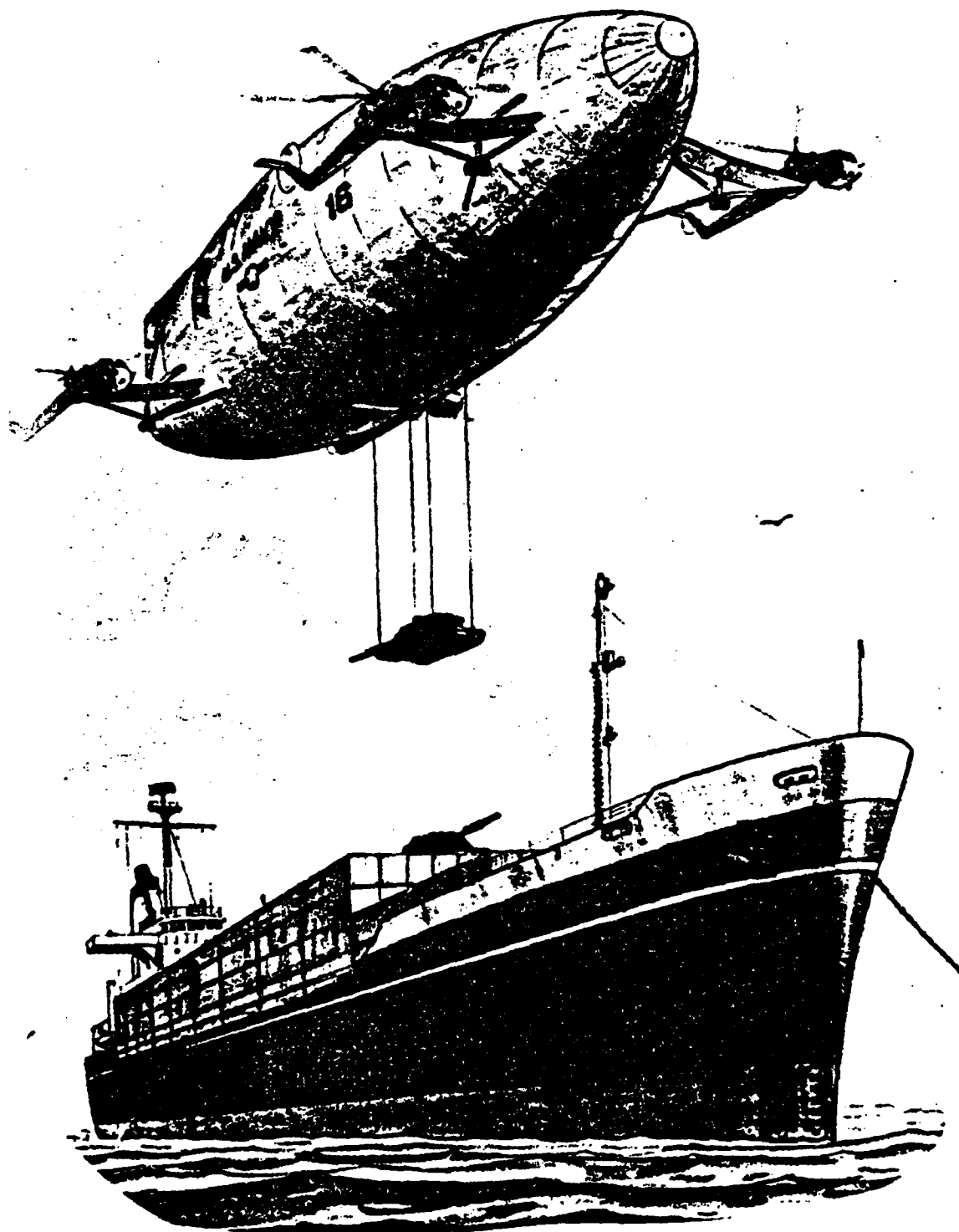


Figure IV-13. Helistat

Source: Graeter, p. 58

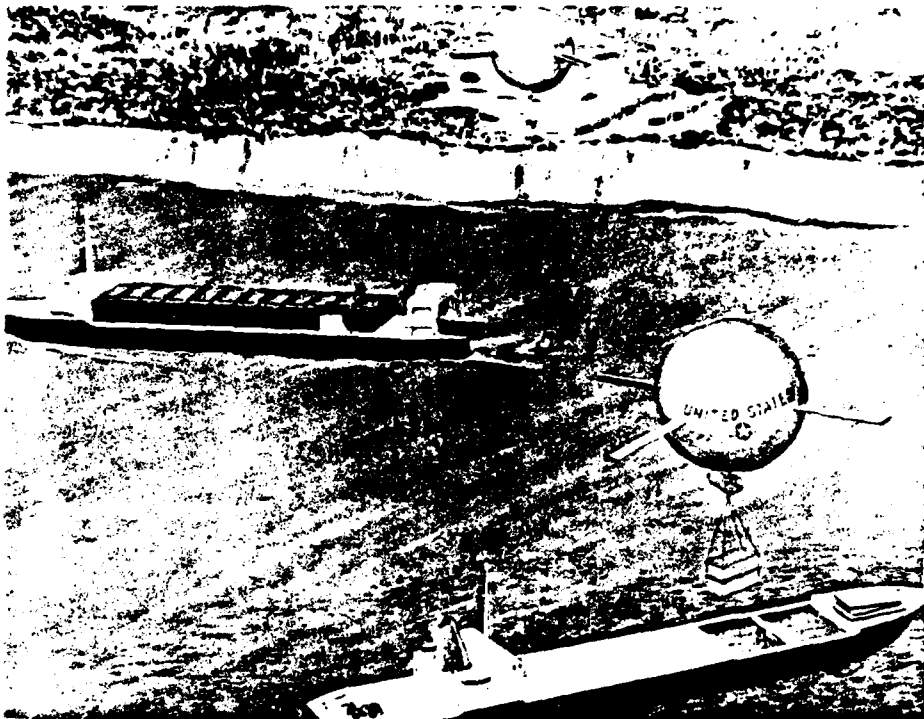


Figure IV-14. Aerocrane

Source: (COTS) Container Offloading and Transfer System, p. 13

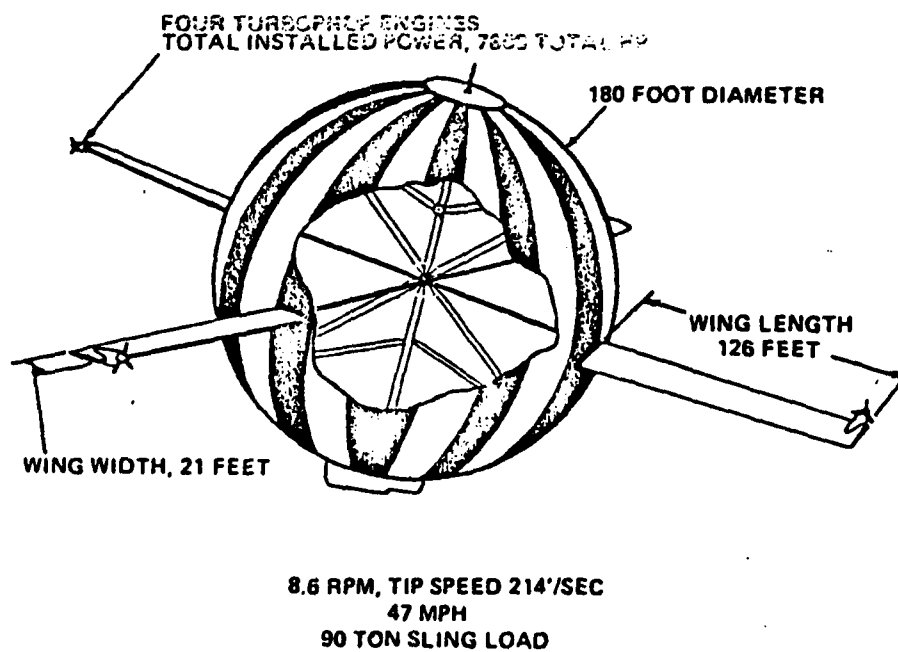


Figure IV-15. Aerocrane
Source: Graeter, p. 54.

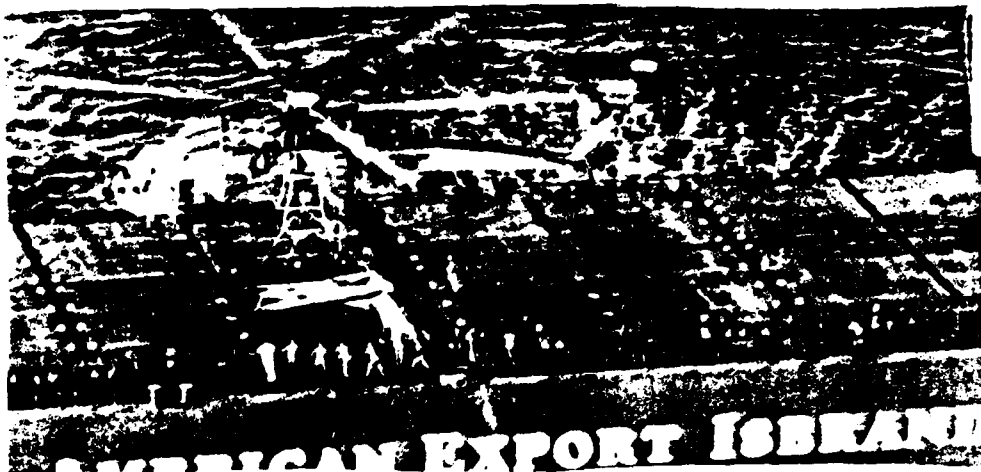


Figure IV-16. Helicopter Container Offloading

Source: (COTS) Container Offloading and Transfer System, p. 12



Figure IV-17. Elevated Causeway with Crane on Pierhead

Source: (COTS) Container Offloading and Transfer System, Vol. II, p. 19

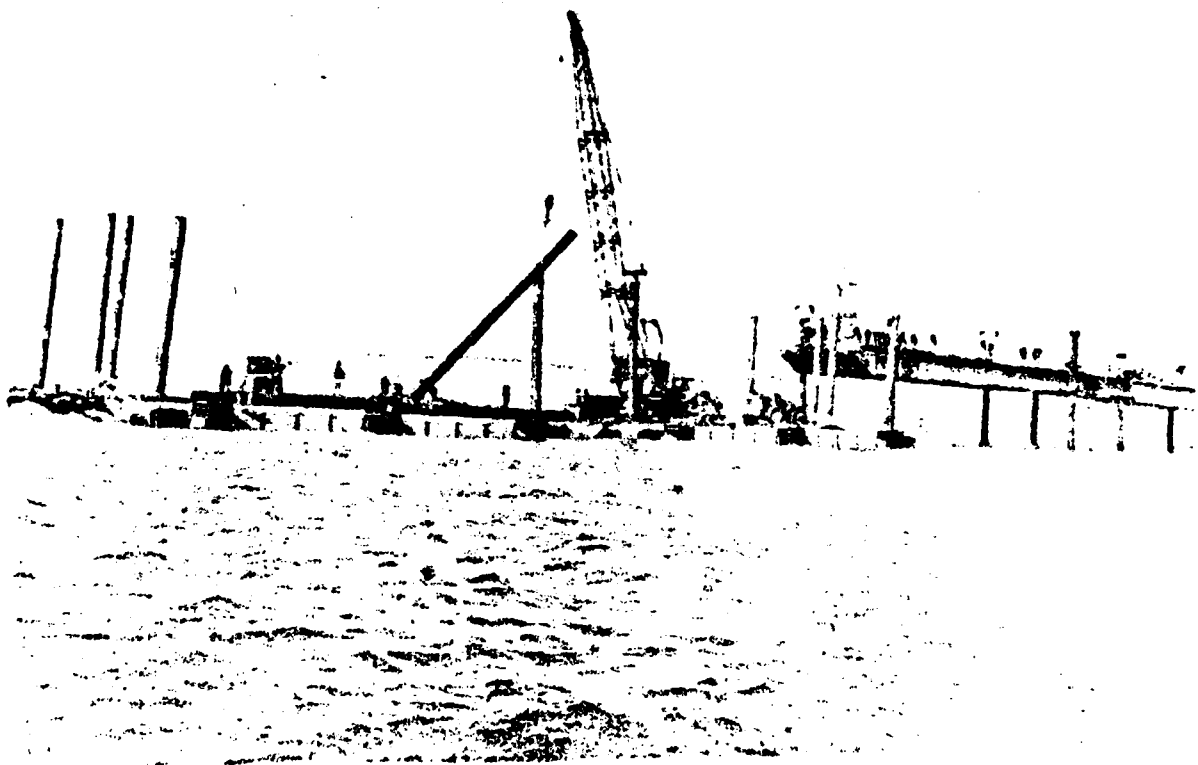


Figure IV-18. Causeway Elevation in Process

Source: Integrated Logistic Support Plan for Elevated Causeway System of the Container Offloading and Transfer System (COTS), p. 3-13.

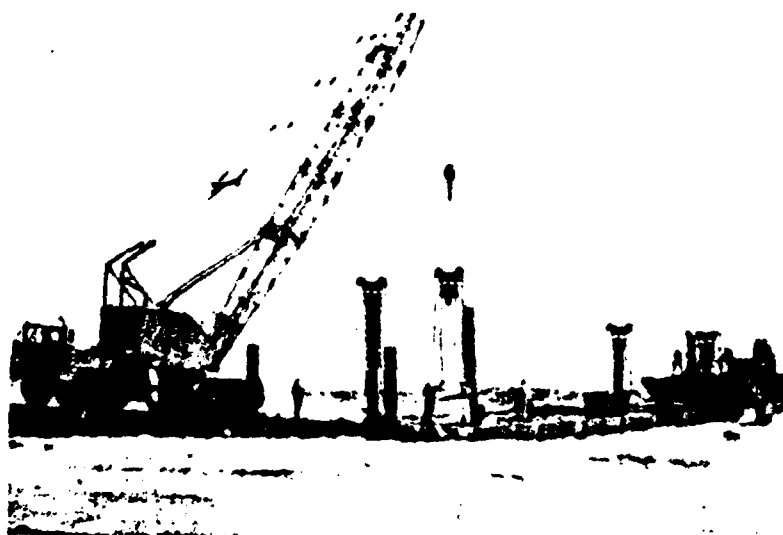


Figure IV-19. P & H Model 80-1000, 90-Ton Truck Crane

Source: (COTS) Offloading and Transfer System,
Vol. II, p. 19

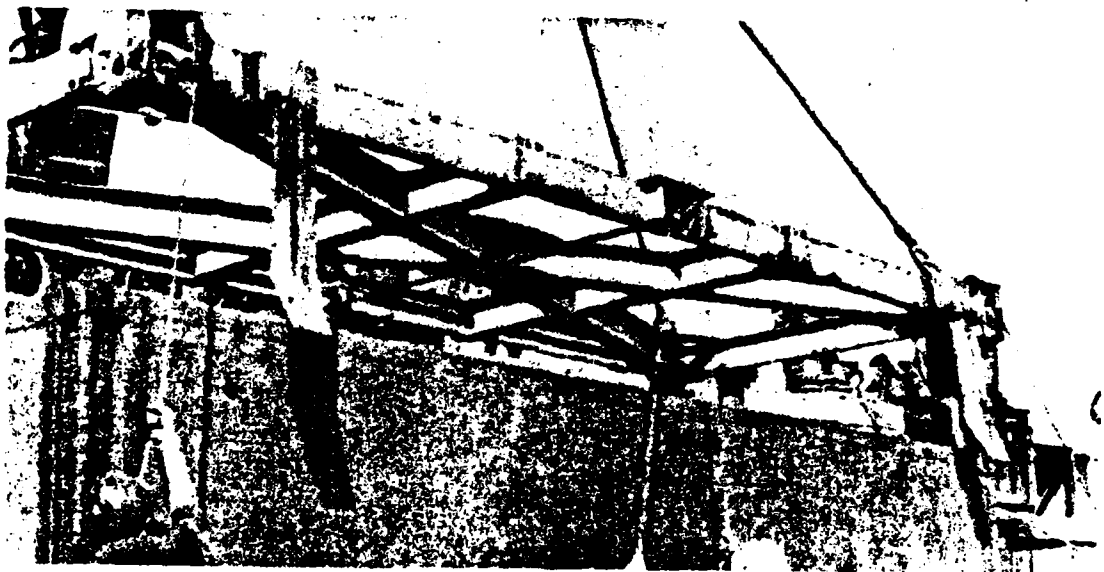


Figure IV-20. Manual Spreader Bar

Source: (COTS) Offloading and Transfer System,
Vol. II, p. 19

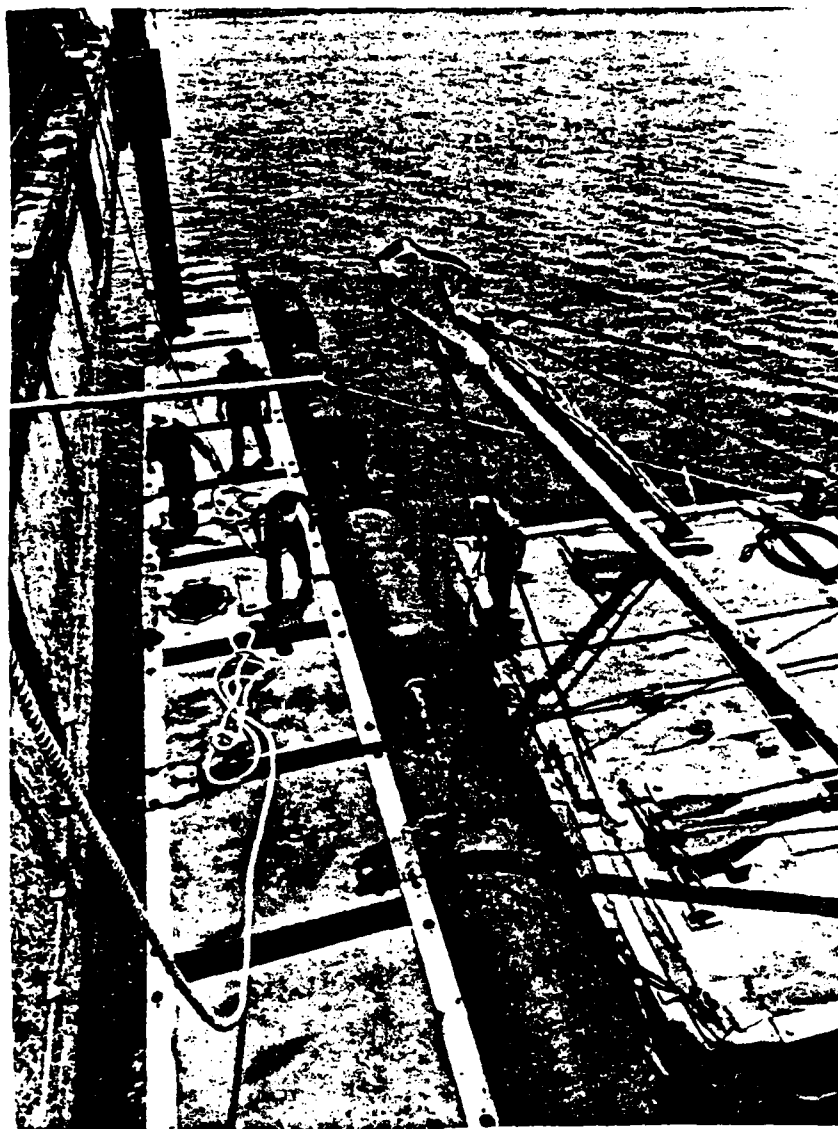


Figure IV-21. Installation of Fender System

Source: Integrated Logistics Support Plan for Elevated Causeway System of the Container Offloading and Transfer System (COTS), p. 3-11

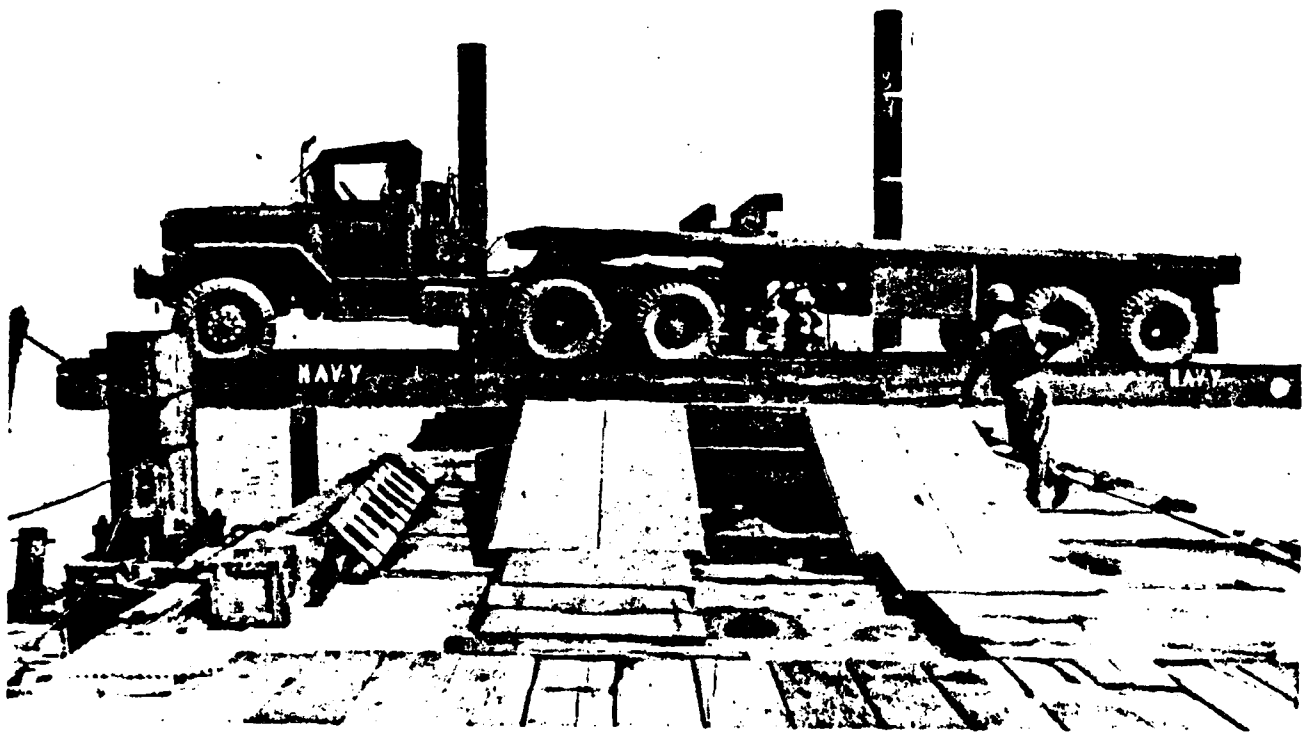


Figure IV-22. Turntable Rotating M52 Tractor with
M127 Trailer

Source: Integrated Logistic Support Plan for Elevated
Causeway System of the Container Offloading
and Transfer System (COTS), 3-15.

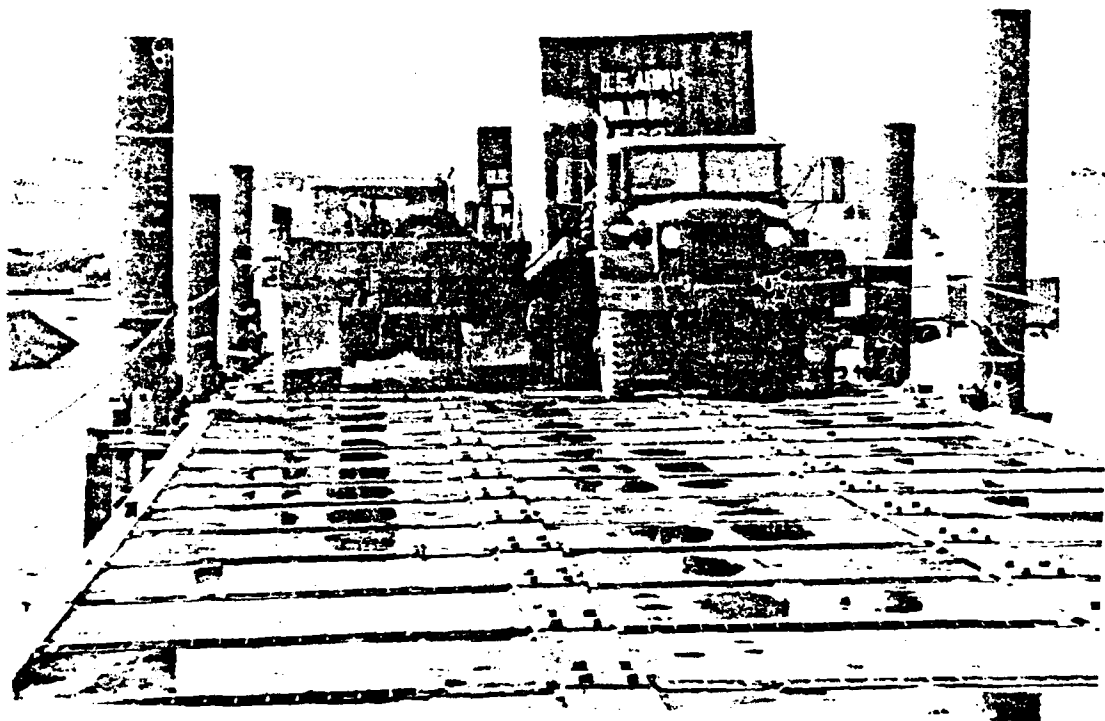


Figure IV-23. Elevated Causeway Allows Two-Way Traffic

Source: Integrated Logistic Support Plan for Elevated Causeway System of the Container Offloading and Transfer System (COTS), p. 3-6

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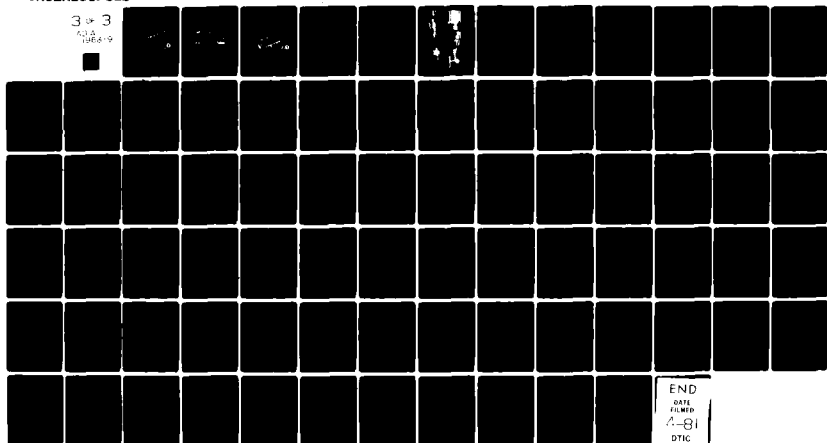
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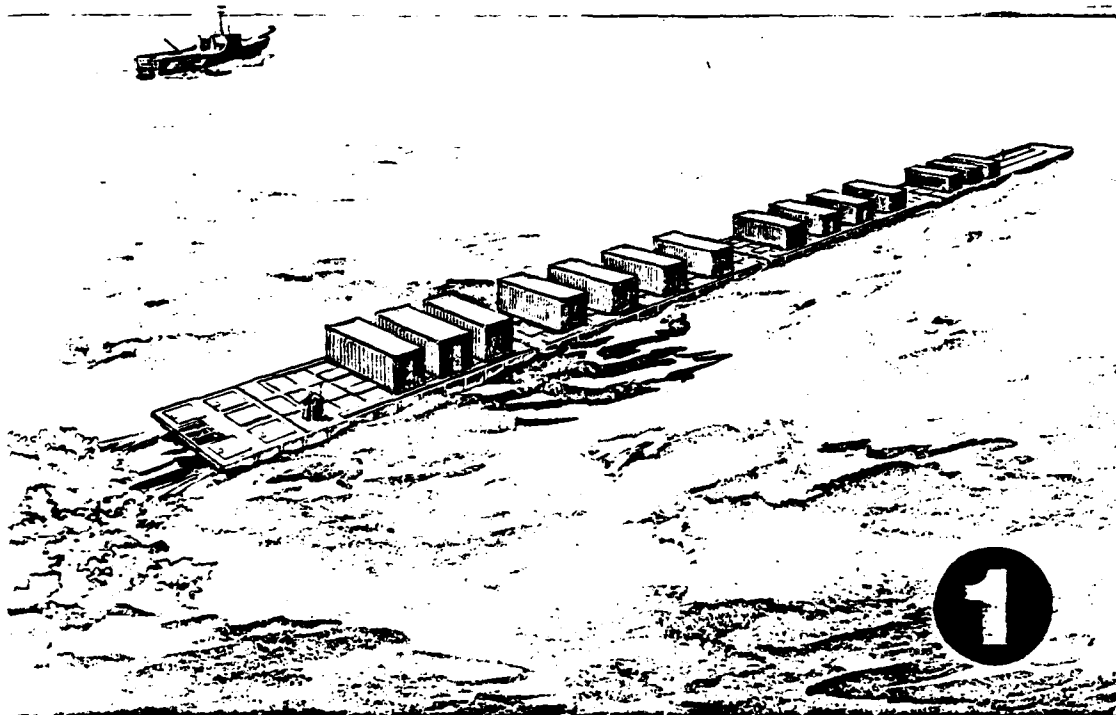


Figure IV-24. Powered Causeway Ferry

Source: Self-Powered Causeway System, p. 1

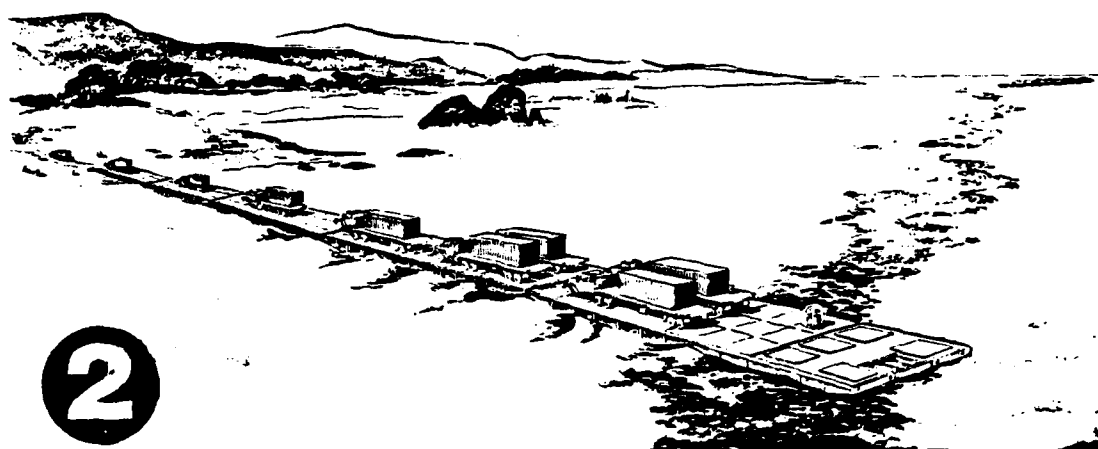


Figure IV-25. Self-Propelled Causeway

Source: Self-Powered Causeway System, p. 2

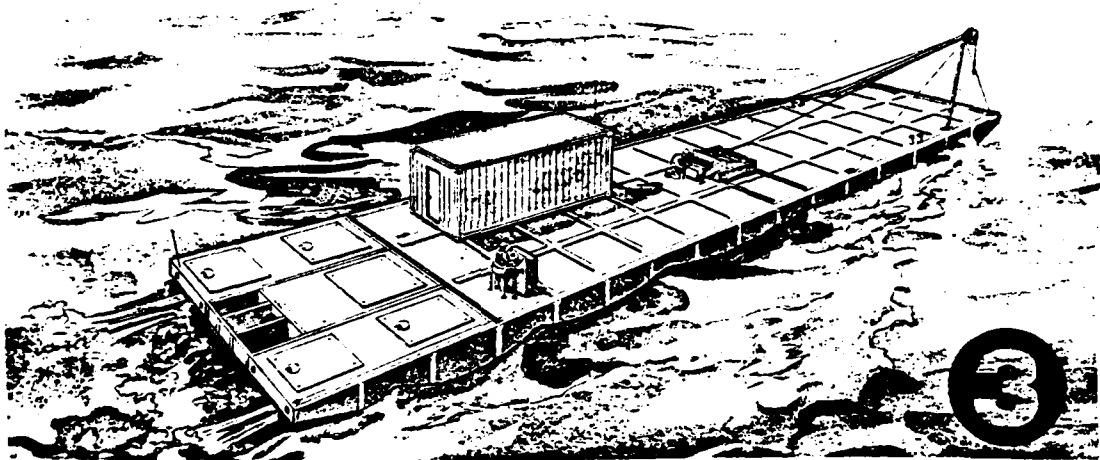


Figure IV-26. Side-Loadable Warping Tug

Source: Self-Powered Causeway System, p. 3

OPERATIONAL CHARACTERISTICS ... POWERED CAUSEWAY SECTION

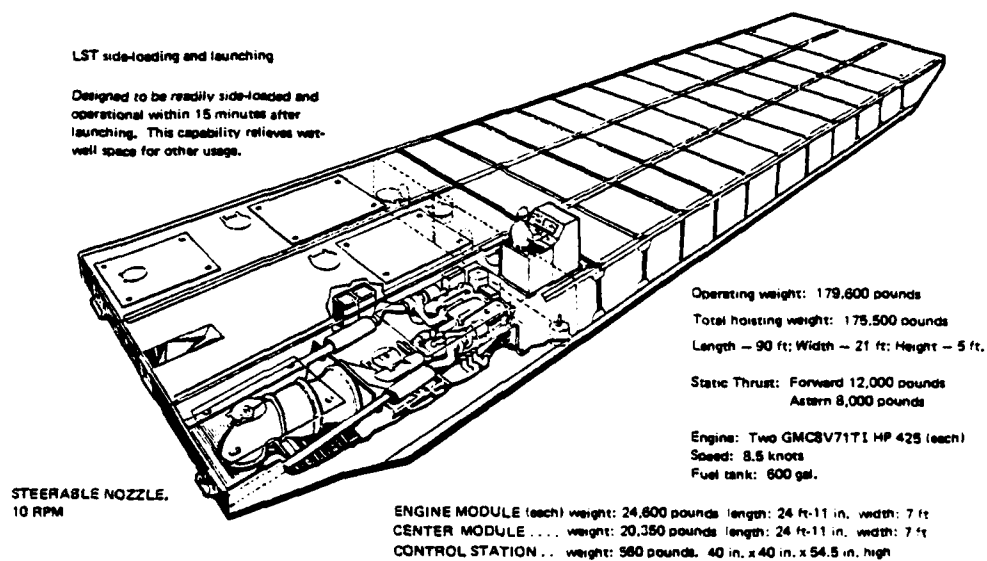
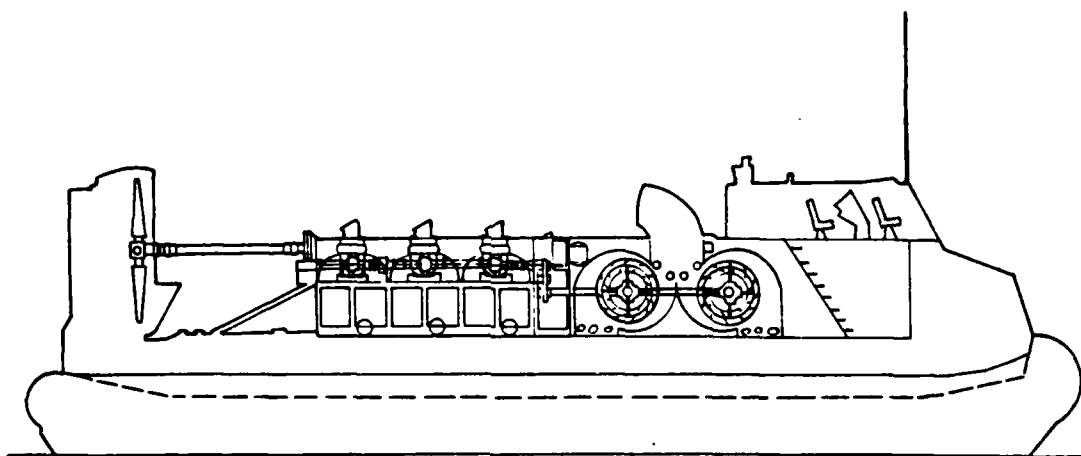


Figure IV-27.

Source: Self-Powered Causeway System, p. 3



LENGTH, HARD STRUCTURE	80 ft 0 in.
LENGTH, OVERALL (on-cushion)	87 ft 7 in.
BEAM, HARD STRUCTURE	43 ft 0 in.
BEAM, OVERALL (on-cushion)	47 ft 0 in.
HEIGHT, OVERALL	11 ft 0 in.
HEIGHT, (off-cushion)	8 ft 0 in.
WEIGHT GROSS	323,000 lb
WEIGHT, (on-cushion)	150,000 lb
HEIGHT, (off-cushion) (design weight)	3 ft 4 in.
AREA, CARGO DECK	1,740 sq ft

Figure IV-28. Amphibious Assault Landing Craft (JEFF B)

Source: Systems Analysis of Amphibious Assault Landing Craft: Beach Cargo Handling Analysis, p. 51

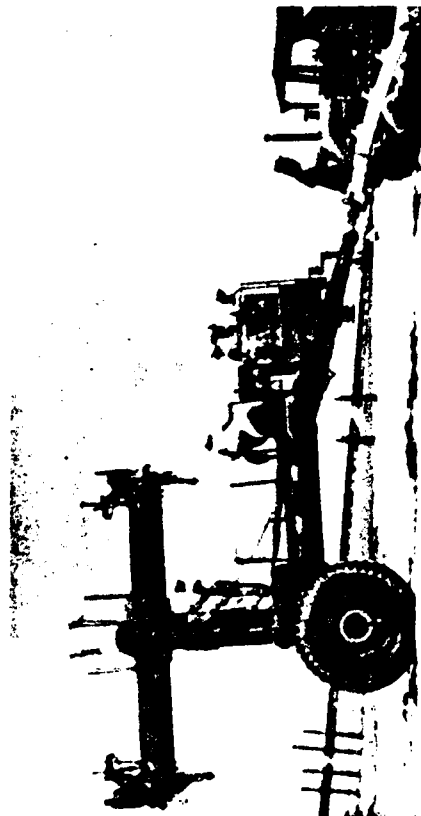
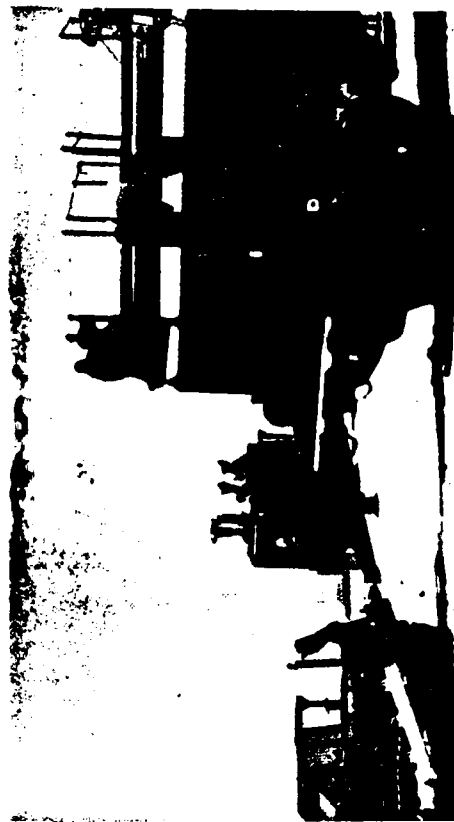


Figure IV-29. Light Amphibious Container Handler (LACH)

Source: (COTS) Container Offloading and Transfer System, p. 21

Table IV-1

General Characteristics of a Typical 225-Ton Capacity Crane

Basic Machine Weight (incl. 135,000 lb counter weights)	360,270 lb
Length (without boom base)	38 ft 11 in.
Length (with boom base)	73 ft 11 in.
Width (for transportation)	18 ft 7 in.
Width (for operations - traces extended)	21 ft 1 in.
Tailswing (for operations)	24 ft 7 in.
Height (for operations, boom not included)	30 ft 4 in.
Height (for transportation)	14 ft 10 in.
Lifting capacities (with 90-ft boom) at:	
25 ft	229,980 lb
60 ft	66,840 lb
90 ft	38,650 lb

Source: Main Test Design of the Joint Logistics-Over-the-Shore (LOTS) Test and Evaluation Program, p. 19

Table IV-2

Characteristics of a Hatch Bridging Kit

Length	43 ft
Width	4 ft 2 1/4 in.
Height	3 ft
Weight (each beam)	36,000 lb

Source: Main Test Design of the Joint Logistics-Over-the-Shore (LOTS) Test and Evaluation Program, p. 20

Table IV-3

U.S. FLAG RO/ROs AND PARKING AREAS				
CLASS	No. AVAILABLE	PARKING AREA (ft ²)	TOTAL AREA FOR CLASS (ft ²)	PERCENTAGE OF TOTAL
Ponce/Lurline	6	150,000	900,000	36.9
Great Land	4	210,000	840,000	34.4
Maine	4	150,000	600,000	24.6
Defiance	4	25,000	100,000	4.1

Source: Naval Engineers Journal, p. 44

Table IV-4

COMMERCIAL U.S. RO/RO SHIP CHARACTERISTICS

CHARACTERISTIC	MAIN CLASS	PONCE/LURLINE CLASS	GREAT LAND CLASS
Ships Available	4	0	4
Length (ft)	~84	700	~90
Breadth (ft)	102	105	105
Draft (ft)	32	28	28
Speed (knots)	23	24	24
Cargo Deadweight (LTons)	14,000	11,000	15,000
Measurement (tons)	45,000	34,000	50,000 (est.)
Deck Height (ft)			
• Main	N/A ^a	In super 15ft structure tunnels	Under 15ft spar deck
• 2nd	3ft-2in. to 10ft	15ft	15ft
• 3rd	18ft	15ft	15ft
• 4th	17ft	17ft or 15ft ^b	13ft-7in. to 15ft
• 5th	10ft	N/A	N/A
Stern Ports (H x W)	16ft x 40ft	N/A	16ft x 16ft (2)
Side Ports (H x W)	15ft x 14ft (port)	Starboard Side 15ft-3in. x 24ft fwd. 15ft-3in. x 24ft (2 ships)	15ft-3in. x 24ft
	10ft x 24ft (stbd)	11ft x 24ft (4 ships) 15ft-3in. x 21ft aft	15ft-3in. x 24ft

NOTES: a = Not Applicable (N/A)

b = 4 ships of this Class have automobile storage on the lower decks. Height of these decks is approximately 7ft. Where Auto Decks are not installed, the height is generally 15ft.

Source: Naval Engineers Journal, p. 45

Table IV-5

LIMITING VEHICLE CHARACTERISTICS

CHARACTERISTIC	VALUE	LIMIT SET BY
Height	15ft (180in.)	Internal doors of MAINE Class: Interior of PONCE/LURLINE Class
Width	18ft (216in.)	Internal ramps of PONCE/LURLINE Class
Length	50ft (600in.)	Approximate length of 40ft semi-trailer with yard tractor
Weight Total	60 tons	NDF* design limit
Wheel Pressure	90 psi	NDF* design limit
Ramp Breakover Angle	15 degrees +	Predicted external ramp angle from PONCE/LURLINE Class

NOTE: *NDF refers to the National Defense Feature Program whereby the U.S. Government funds the installation of ship design features that exceed commercial needs but that are useful in a national emergency.

Source: Naval Engineering Journal, p. 46

Table IV-6

**COMMON VEHICLES WHICH APPROACH
LIMITING CHARACTERISTICS**

CHARACTERISTICS	VEHICLE
Height	12 Ton Van Trailer, 150in. Crane Hydraulic Boom, 160in. Crane Truck, 157in.
Width	Tractor Crawler, 155in.
Length	5 Ton 6x6 Truck Tractor w/12 Ton Stake Trailer, 520in. 5 Ton 6x6 Truck Tractor w/5,000 gal. Fuel Tanker, 558in. 5 Ton 6x6 Truck Tractor w/low bed Trailer, 592in.
Weight	M60 Tank, 57.2 Tons
Wheel Pressure	Jeep, 90 psi
Ramp Breakover Angle	Low Bed Trailer, 14.5°

Source: Naval Engineering Journal, p. 47

Table IV-7

Maximum Number of Containers in JEFF B Payload

<u>Container</u>	<u>Maximum JEFF B Payload (lb. X 1000)</u>	<u>Number of Containers</u>	<u>JEFF B Container Payload (lb. X 1000)</u>
Half CONEX	150	15	148.5
CONEX	150	14	147.0
TRICON	150	10	149.3
MUST	150	16	112.0
10-foot Van	150	6	134.4
20-foot Van	150	3	134.4
30-foot Van	150	2	112.0
35-foot Van	150	2	100.8
40-foot Van	150	2	134.4

Source: Impact of Containerization on the Advanced Landing
Craft, p. 10.

Table IV-8
Container Dimensions and Weights

Description	Width (ft-in.)	Height (ft-in.)	Length (ft-in.)	Gross Weight (lb)
Half CONEX	6-3	6-11	4-3	9,900
CONEX	6-3	6-11	8-6	10,500
TRICON	8-0	8-0	6-8	14,933
MUST	7-6	8-0	12-0	7,000
10-ft Van	8-0	8-0	9-9.75	22,400
20-ft Van	8-0	8-0	19-10.5	44,800
24-ft Van	8-6.5	8-0	24-0	50,000
30-ft Van	8-0	8-0	29-11.25	56,000
35-ft Van	8-6	8-0	35-0	50,400
40-ft Van	8-0	8-0	40-0	67,200

Source: Impact of Containerization on the Advanced Landing Craft, p. 2.

Table IV-9
Development Milestones

<u>TASKS</u>	FY79	FY80	FY81	FY82	FY83
<u>SHIP OFFLOADING</u>					
Temporary Container Discharge Facility			0		
Crane-on-Deck					
Ro/Ro Low Seastate Ramp				0	
Ro/Ro High Seastate Ramp				0	-
Airborne:					
a. Balloons					a. -
b. Helistat					b. -
c. Aerocrane					c. -
d. Helicopter			d. 0		
<u>SHIP-TO-SHORE</u>					
Elevated Causeway		+			
Powered Causeway Section		+			
Landing Craft Air Cushion (LCAC)		+			
Light Amphibious Container Handler (LACH)		+			

0 Planned
+ Selection
for Development
p. 39.

Table IV-10

Container Offloading Methods for Merchant Ships

SHIP OFFLOADING (CONTAINERS)	TCDF	crane-on-ship	crane on "A" DeLong barge	crane on "B" DeLong barge	COD	Airborne	balloon	helistat	aerocrane	helicopter
Cost		-	-	-	-		+	-	-	-
Development Time		+	+	+	+		+	-	-	+
Deployable		+	-	+	+		+	-	-	-
Effect on cargo capacity		-	+	-	-			+	+	+
Provides for Temporary storage in AOA				+	+		-	-	-	-
Stability in low seastate		+	+	+	+		+	+	+	+
Stability in moderate seastate		+	+	-	+		+	+	+	+
stability in high seastate		-	-	-	-		+	+	+	+
peacetime use		-	-	-	-		-	-	-	+
reach		+	-	-	+		+	+	+	+
lift capacity		+	+	+	+		+	+	+	-
ship/craft mooring		+	+	+	+		-	-	-	+
pendulation		+	+	+	+		-	-	-	+
need for watercraft		-	-	-	-		+	+	+	+
priority is for combat support function		+	+	+	+		+	+	+	-

+ advantage - disadvantage

Table IV-1

Vehicle Offloading Methods for Ro/Ro Ships

RO/RO SHIP OFFLOADING (VEHICLE)	High seastate ramp	Lift device	Low seastate ramp
Cost	-	+	+
Development time	-	+	-
Maneuverability problem in unloading	-	+	-
Unloading relies on driver's skill	-	+	-
Sensitive to seastate 1	+	+	+
Sensitive to seastate 2	+	+	-
Sensitive to seastate 3	+	-	-
Deployable	+	+	+
Reduction in cargo capacity	-	+	-
Peacetime use	-	-	-
Need for watercraft or causeway	-	+	-
Provides other capabilities	-	-	-

+ advantage - disadvantage

Table IV-12

Ship-to-Shore Movement of Containers

<u>SHIP-TO-SHORE</u>	Cost	Time to implement in AOA	Sensitivity to seastate	Container handling rate	Deployable	Maintenance
Elevated Causeway	+	-	+	+	+	+
Self-Propelled Causeway	-	+	-	+	+	-
LCAC	-	+	-	+	+	-
LACH	+	+	+	-	+	+

+ advantage

- disadvantage

V. CONTAINER-ORIENTED LOGISTICS IN AMPHIBIOUS OPERATIONS

A. INTRODUCTION

On the approval of President Nixon, a Joint Logistics review board was established on March 1, 1969. The purpose of the review board was to determine the strengths and weaknesses of logistic support during the Vietnam era.¹ The board analyzed the logistics operations of the military services. It recommended establishing a Department of Defense (DOD) container-oriented logistics system. The board's recommendations were based on the economic benefits of containerization and the trend toward containerships.²

A DOD project to develop a container distribution system was initiated in 1971. The United States Army (USA) was designated the executive service for the surface container-oriented logistics system and the United States Air Force (USAF) for the air system. A Logistics Systems Policy Committee assisted by a Joint Container Steering Group was established to coordinate the containerization effort.³

Since 98 percent of DOD's cargo resources are moved by surface transportation, the USA had the biggest job.⁴ A master plan was developed and today, some ten years later, critical elements of the system are still lacking. The effective use of containers in an emergency or war is impossible.⁵

The Government Accounting Office (GAO) study states that the following general reasons for the lack of an adequate container-oriented logistics system:

1. the complexity of a container distribution system requires intensive management (DOD has never applied such management to this program).
2. the executive service approach creates difficulty in making policy decisions, resolving interservice disputes and monitoring and coordinating the development effort.
3. a lack of funding has hindered timely system development.
4. the steering group has not provided the timely guidance for attaining satisfactory progress in achieving a container-oriented distribution system. Disagreement from members of the various services creates the biggest problem.
5. there has been a lack of a comprehensive system concept description and delineation of developmental responsibilities to each DOD activity to ensure standard equipment, policies and procedures.
6. there is no method for ensuring that the services follow the developmental tasks in the master plan.⁶

Since this study is primarily concerned with amphibious operations, this final analysis will be dedicated to reviewing the United States Marine Corps (USMC) program that is being developed with a view toward the container-oriented logistics system. Specifically, the Marine Corps Container System (MCCS) will be described and evaluated. Prior to

analyzing this system, a general background of containerization will be presented.

B. BACKGROUND

Containerization involves shipping cargo in truck-like bodies (containers) that can be detached from the chassis of a truck by specialized material handling equipment (MHE). Containers can be loaded into specially constructed ships for ocean transport, loaded onto rail flatcars, or attached to a prepositioned chassis and trucked inland.⁷

Containerization in the commercial transportation industry has many advantages over conventional (breakbulk) transportation:

1. time in transit is greatly reduced (ships can be loaded and unloaded within 24 hours).
2. less damage occurs in properly loaded containers.
3. containers can be loaded and sealed by shippers either at a port or some inland point and remain unopened until they reach overseas consignees.⁸

Containers are generally constructed so that they have rigid steel frames as a primary structure covered by thin, light skins of steel, aluminum, fiberglass, or, in some cases, wood or cardboard. Corner posts with interlocking devices allow stacking in a variety of ways. Flooring materials are recoverable and reusable.

As pointed out previously, the container has brought revolutionary changes to the shipping industry. The older

and nearly obsolete breakbulk ships had flexibility in the types of cargo that could be carried. However, they were characterized by labor-intensive loading and unloading methods. The newer containership is larger, faster and designed specifically for carrying large commercial containers. Its loading and unloading depends upon an equipment-intensive port facility.

The revolution toward containerization has not been without problems. At the onset, each company produced its own unique sized and shaped container based on its own needs and requirements. This caused compatibility problems with container handling equipment, trucking and shipping configurations. The American National Standards Institute (ANSI) and the International Organization for Standardization (IOS) have made significant contributions toward solving the container standardization problem.⁹ The most predominant sizes are the 8 X 8 X 20-foot and the 8 X 8 X 40-foot containers.¹⁰ These sizes are now the basis for design of container-oriented transportation and handling equipment.

There are exceptions to the standardization effort. The Matson Company and Sealand Inc. built containers prior to the guidelines set forth by the ANSI and IOS. The Matson Company designed an 8 X 8 X 24-foot container and Sealand Inc. uses an 8 X 8 X 35-foot container. The latter two sizes were once required by highway regulations. Matson's and Sealand Inc.'s investments in the containers were so substantial that scrapping them was never a consideration.¹¹

The container standardization program has a big impact on the military. Containers designed for military use must be designed to be compatible with the commercial and military transportation systems. Further, MHE brought into the military inventory must be capable of handling ANSI/IOS standardized containers. In amphibious operations of the future, an effectively functioning container-oriented logistics system is essential. This system must be completely integrated and entirely compatible with both military and commercial shipping assets.

C. MCCS

1. Background

In response to the requirement to have a container-oriented logistics system, the USMC is developing the MCCS. The family of containers included within this system will have the capability to be employed in garrison, afloat or amphibious operations. Four basic container sizes for general cargo are needed. They are as follows:

a. a large container required to provide maximum cargo throughput capability. This container will be used primarily in the assault-follow-on echelon (AFOE) and in a warehousing capacity once ashore. This container is designed to be carried by commercial containerships.

b. an intermediate-size container, compatible with storage and cargo-handling configurations of both United States Navy (USN) amphibious ships and commercial ships. This container

will be used primarily to unitize bulk supplies and support storage and movement supplies for organizational property. It could be used in the assault echelon (AE) and the AFOE.

c. a pallet-size container for ease in handling and storage. This container would store individual unit property. It could be offloaded from USN or commercial ships and could be utilized in both the AE and AFOE.

d. a mount-out-size container which can be used as a storage box or an insert in the intermediate or pallet-size container.¹²

In addition to the container types listed above, there is a requirement for a flatrack container to transport large, irregularly-shaped items, such as bridging and shelter-system components.

2. Current System

The current system of transporting supplies to the amphibious objective area (AOA) is based on locally assembled wooden boxes (mount-out boxes), box pallets and flat pallets. This system is behind modern state-of-the-art methods of packing, handling and moving cargo. The present wooden mount-out boxes and pallets provide a limited degree of cargo unitization, but are still in the breakbulk category. The amount of cargo that can be put into a mount-out box or on a pallet is considerably less than the amount that can be loaded into an 8 X 8 X 20-foot or an 8 X 8 X 40-foot container. The current box/pallet-oriented logistics system does not

permit adaptability to containerships and other merchant vessels configured for containerized rather than breakbulk cargo.

The specific operational deficiencies of the current box/pallet logistics system are listed below:

- a. they do not provide the required compatibility with modern cargo transports.
- b. mount-out boxes require assembly by the using military unit.
- c. they have limited cargo capacity when compared to modern commercial containers.
- d. they require significantly more handling time over a containerized system.
- e. handling is more labor-intensive than a containerized system.
- f. they are of poor construction and consequently have a short service life.
- g. they are not weatherproof without expenditure of additional resources.
- h. they provide limited protection to contents, making damaged cargo a serious problem.
- i. they require cargo to be banded with heavy steel wire necessitating the need for banding and rebanding.¹³

3. Containers in an Amphibious Environment

The purpose for employing containers in an amphibious environment in the Fleet Marine Force (FMF) is to provide a

means of cargo unitization to facilitate an increase in cargo handling and transportation efficiency, and to improve the protection of supplies during transportation and storage. The containers must be capable of safe and efficient use in all areas of the world, on all types of terrain and in varying climatic conditions.

The current MCCA concept will allow all USMC FMF units to have a specific number of containers authorized by their respective table of equipment (T/E). The containers will be utilized in garrison to store organizational property and consumer supplies in a state of mount-out readiness. In day to day operations, they will serve as storage cabinets in unit warehouses, which will contribute to more organized and efficient warehousing operations. A containerized warehousing system will permit rapid movement of an entire unit supply warehouse to a field location. Upon arrival, the unit supply section will be able to commence immediate operation.

Aboard ship, the containers can be used to facilitate normal supply operations. For example, maintenance repair parts can be issued right from the containers, allowing both corrective and preventive maintenance to be performed on equipment while enroute to the AOA.

During the conduct of an amphibious operation, the containers will be unloaded and moved ashore during the AE and AFOE. Once ashore they will serve as field warehouses in the logistics support area (LSA), or in each individual

unit's support area. Containers will serve as the source of supply for immediate material consumption requirements or for organizational supplies. Table V-1 lists the USMC classes of supply that are transported to the AOA. The percentage of these supplies that are containerizable are included.

Under the MCCS concept, containers will require a minimum of maintenance support. All maintenance will be performed at the using unit level. Organizational containers will be returned back to designated maintenance establishments on a programmed basis.

4. Essential Containers for Amphibious Operations

Previously, the containers of the MCCS included: a pallet-size container, an intermediate-size container, a large-size container, a small mount-out container and flatracks. All containers must be compatible with commercial shipboard handling and stowage. Material selected for the containers will incorporate the latest technology in corrosion control. A description of each type of container planned for the MCCS will follow.

a. Pallet-Size Container (PALCON)

The pallet-size container will be essentially a weather-proof box called a PALCON. Each dimension of the PALCON will be four feet (ft.) and it will have a four-way forklift capability. It will have fittings suitable for attaching slings for helicopter or crane lift. The PALCON will also have hardware for latching the containers into arrays

up to 20 ... give it compatibility with ... the PALCON will be strong enough to hold approximately 1,400 lb.¹⁴ Doors in the front of the container will provide access and each container will have an optional bin insert capability. This will allow for the storage and transportation of smaller items. A rack can be installed in the PALCON that can guide and support up to six insert trays.¹⁵ The PALCON can be effectively handled, transported and utilized both afloat and ashore.¹⁶ The PALCON is small and transportable enough to be part of the ground combat elements. It can be employed in the same unit warehouses in which the current 4.2-foot wooden mount-out box is currently used. In preparation for deployment, it will be a simple matter of closing the door and the PALCON is ready to move. Mount-out stocks, repair parts, consumable supplies, replacement items and various other operating and training stocks can be assembled and binned in the PALCON. With adjustable bins inside, a greater warehousing capability will be possible, reducing container requirements. It was determined through computer simulation that 1,000 tons of cargo containerized in PALCON's and handled in arrays consisting of eight containers could be discharged from shipping in half the time required for palletized cargo.¹⁷

The PALCON is expected to be completely compatible with the following assets:

- (1) USN amphibious ships
- (2) merchant dry cargo shipping

- (3) all types of lighterage in the USN's inventory
- (4) MHE in the USMC's inventory
- (5) motor transport equipment in the USMC's inventory
- (6) cargo-carrying helicopters and aircraft in the USMC's inventory (this includes the CH-46 and CH-53 helicopters and the C-130 fixed-winged aircraft).

b. Intermediate-Size Container (QUADCON)

The intermediate-size container in the MCCS will be a 5 X 8 X 6.5-foot container called a QUADCON. It is designed for loads up to 10,000 lb. QUADCON's will have four-way forklift handling capability and hardware for connecting into arrays of four (thus the name QUADCON) to form a standard 20-foot container. Therefore, the QUADCON can meet IOS standards making it compatible with commercial container-carrying shipping. Access will be through doors at each end and the container will have the capability to carry the same bin inserts as the PALCON. The QUADCON also has the optional bin rack insert.¹⁸

Combat service support units such as the supply and maintenance units of the landing force will be the primary utilizer of the QUADCON. The container will be employed to unitize bulk supplies and items too large for a PALCON. USMC helicopters are capable of lifting the 10,000-pound (gross weight) QUADCON. As determined previously, this is a big advantage in ship offloading. Once ashore in the AOA, QUADCON's would not go any further than the LSA. They are

too big and lack the mobility to be part of the ground combat unit's T/E.¹⁹

The compatibility of the QUADCON with various types of shipping equipment and aircraft can be summarized as follows:

(1) Amphibious Ships. The QUADCON has limited compatibility primarily due to the lack of MHE for internal movement of 10,000-pound loads. Its size makes it not suitable for stowage in general cargo spaces due to the overhead constraints. Vehicle spaces, however, provide ample room for QUADCON storage.

(2) Merchant Ships. There exists a high degree of compatibility with containerhips and barge carriers since the QUADCON does meet IOS standards; however, it has limited compatibility with breakbulk ships and Roll on/Roll off (Ro/Ro) ships. This is due to the fact that the latter are not designed as container-carrying ships.

(3) Lighters. QUADCON's are completely compatible with all lighters in the USN's inventory.

(4) MHE. A QUADCON can be lifted by the following in USMC's inventory:

(a) light amphibious container handler
(LACH)

(b) the 10,000-pound, 48-inch load center,
rough-terrain forlift

(c) the 30-ton, wheel-mounted, rough-
terrain crane

- (d) the 15-ton truck-mounted crane
- (e) the 12 $\frac{1}{2}$ -ton crawler-mounted crane.

It cannot be lifted, however, by the 4000-pound, 24-inch load center, rough-terrain forklift nor by the 7 $\frac{1}{2}$ -ton wheel-mounted crane.

(5) Motor Transport. The QUADCON can be hauled by the following trucks in the USMC's inventory:

- (a) the semi-trailer, 6-ton M118A1
- (b) the semi-trailer, 12-ton M127A2C with M52A2 tractor
- (c) the semi-trailer, 25-ton M172A1 with M123 tractor
- (d) the truck, cargo 5-ton M54A2C

The QUADCON is not compatible with the semi-trailer 65-ton tank transporter nor the truck, cargo 2 $\frac{1}{2}$ -ton M35A2C.

(6) Aircraft. The QUADCON can be transported by the CH-53 helicopter and the KC130 fixed-winged aircraft.²⁰

c. Bin Insert

The bin insert is compatible with both the PALCON and the QUADCON containers. It is a covered box approximately 45 X 17 X 10 inches with adjustable dividers. The box, in addition to being used as a container insert, is also a replacement for the present wooden mount-out box. It has a tare weight* of 35 lb. and a cargo capacity of 120 lb. Six inserts can be installed into the PALCON container and

*See glossary of terms.

36 into the QUADCON.²¹ The insert is constructed of a foam molded plastic with a handler at each end.²²

d. Large Container

The large 8 X 8 X 20-foot container is similar to the container used in the commercial transportation environment. The container has an exterior volume of 1,280 cubic feet (cu. ft.) and an interior volume of 1,110 cu. ft. It has a tare weight of 3,600 lb. and a cargo weight of 41,200 lb.²³ It is weatherproof and is used for transporting and storing unit loads, packages and bulk material.

This large commercial container provides large capacity while protecting the contents from loss or damage. Metal, plywood or a combination of both can be used to construct the large container. Construction, dimensions, fittings and features conform to ANSI/IOS standards.

The 8 X 8 X 20-foot container will be employed during the AFOE of a Marine amphibious force (MAF)-size operation. Due to its large size and weight, the container could not be employed any further in than the LSA. When emptied, the commercial-size container can be stuffed with retrograde material for shipment out of the AOA. The compatibility of the large commercial 8 X 8 X 20-foot container with various types of shipping, equipment and aircraft can be summarized as follows:

(1) Amphibious Ships. USN cargo ships are configured primarily for bulk cargo. Large commercial containers

are essentially incompatible with the general cargo spaces. Also, there is no capability for internal handling of the 8 X 8 X 20-foot containers.

(2) Commercial Ships. Large containers have excellent compatibility with container ships and barge carriers. This statement assumes a solution to the container discharge problem in the AOA.

(3) Lighter. Large commercial 8 X 8 X 20-foot containers are compatible with all lighters in the Navy's inventory.

(4) MHE. The LACH is the only MHE currently in or projected into the USMC's inventory that can handle the large commercial container.

(5) Motor Transport. There is little capability in the USMC's inventory for land transportation of large containers. The semi-trailer, 12-ton M127A2C with M52A2 tractor is the only capable vehicle, but it would require modification to accommodate the weight of the container.

(6) Aircraft. The large container is not compatible with any aircraft in the USMC's inventory.²⁴

e. Flatrack

A flatrack is an open-sided, open-ended and open-topped platform carrier with 8-foot vertical-end columns. There are 20-foot and 40-foot flatracks and both conform to ANSI/IOS standards. The flatrack is needed to pack and ship material which due to its irregular shape cannot

be packed in enclosed containers. The reverse-osmosis, water-purification unit, needed by the USMC landing force ashore, is an example of a piece of equipment that would be transported in a flatrack. The compatibility of the flatrack with various types of shipping and equipment can be summarized as follows:

(1) Amphibious Ships. Because of its large size, it is incompatible with the general cargo spaces of USN amphibious ships. The lack of internal handling equipment would also pose a major problem.

(2) Commercial Ships. Because of its conformity to ANSI/IOS standards, the flatrack has excellent compatibility with containerships and barge carriers. As with the 8 X 8 X 20-foot commercial container, this assumes a solution to the container discharge problem from non-self-sustaining container-ships in the AOA.

(3) Lighters. Flatracks are compatible with all lighters in the USN's inventory.

(4) MHE. A great deal depends upon the size, weight and shape of the equipment contained in the flatrack. It is expected that the LACH has the capability to handle the 8 X 8 X 20-foot flatrack on the beach. A great deal of testing with different types of cargo needs to be accomplished in this area.

(5) Motor Transport. As with MHE, a great deal depends upon the size, weight and shape of the cargo. The

semi-trailer, 12-ton M127A2C with M52A2 tractor is the only motor transport item in the USMC's inventory that can be relied upon to carry the flatrack.

(6) Aircraft. Due to the flatrack's large size and weight, it is not compatible with any USMC aircraft.²⁵

f. Current Status and Cost Forecast

Exploratory development efforts have produced preliminary designs and structural analyses for the PALCON and the QUADCON containers, bin inserts and supporting racks. In the first quarter of fiscal year (FY) 1980, the Marine Corps Development and Education Command, Quantico, Virginia, reported initial QUADCON units were scheduled for completion in mid-June with developmental testing slated during the third quarter FY80.²⁶ Feasibility of various types of materials have been explored and models have been constructed by Rohr Industries of Chula Vista, California. The development of these containers does not present any distinct obstacles regarding technical approach and risk.²⁷

Eight PALCON demonstration models were tested by the First Marine Division Support Group on June 7, 1978, at Camp Pendleton, California. Testing was conducted on the beach and included loading and stacking the PALCON onto USMC flatbed trailers. The testing was considered successful. PALCON models were arrayed, loaded onto a trailer and unloaded with various types of MHE in the USMC's inventory. Some problems were experienced with minor hardware items. It was

also recommended that further testing should be conducted under more adverse weather conditions.²⁸

The forecasted cost of the containers which make up the MCCS is included in table V-2.

g. Acquisition Plan

Full-scale development and operational testing for the intermediate-size containers will commence in FY81 with the delivery of pre-production prototypes. Current plans call for enough inserts, PALCON's and QUADCON's to outfit a Marine amphibious unit (MAU) for operational testing in the 1981 North Atlantic Treaty Organization (NATO) operations.²⁹

Based upon the results and analyses of all developmental and operational testing, a procurement data package will be published. A procurement decision is currently scheduled for the end of FY81. Production contracts will be awarded for the number of containers that can be funded. At the same time, efforts will be undertaken to acquire commercially available containers needed to satisfy requirements. In order to reduce costs and keep the successful contractor in production, multi-year procurement is planned.³⁰

h. Other Considerations in a Container-Oriented Logistics System

The ship-to-shore movement and beach unloading of containers have been addressed and analyzed in this study. Two other considerations that are necessary for a complete container-oriented logistics system in the AOA are

worthy of mention. First is the motor transport available to move a fully loaded 22.5-ton container once ashore; and second is a soil stabilization system capable of supporting container loads in sandy areas.

(1) Motor Transport. Assuming no modification to current motor transport assets, the FMF does not have the capability to transport an 8 X 8 X 20-foot commercial container inland from the AOA. To solve this problem, a request for a proposal for a heavy prime mover and a 22.5-ton logistics trailer has been released to industry by the USMC in the second quarter of FY80. Present plans call for the procurement of prototypes and commencement of a concept validation test by 1 January 1981.³¹

(2) Soil Stabilization. Soil stabilization materials to support a payload of 22.5 tons across a sandy beach is required. Motor transport matting (MO-MAT), a reusable fiberglass matting currently in the USMC's inventory, is suitable for use in situations in which a small area is to be established for a short period of time. This material is not appropriate where relatively large areas, such as an LSA, may require a stabilizing agent.³²

The system showing the most promise for an unimproved shoreline is the collapsible grid-soil-densification system. The grid can best be described by its similarity to egg carton separators. It is composed of a 4 X 4-foot lattice section made of 6-inch wide aluminum slats. The

lattice section folds almost flat into a manageable unit six inches wide and eight ft. long. These units weigh less than 30 lb. and can be carried in sheaves across the tines of a 4000-pound rough-terrain forklift. The grid system can be installed at the rate of 2000 square feet (sq. ft.) per hour. In an amphibious operation, a rate of 600 sq. ft. is considered satisfactory. Due to its transportability, efficiency and rapid rate of installation, the grid-soil-densification system has promise for solving the surface stabilization problem in the AOA.³³

D. CONCLUSIONS

The USMC has under development a very innovative container system designated MCCS. Some of the elements of this system are compatible with USN amphibious ships for use in the AE and all the elements are compatible with container-carrying merchant ships for use in the AFOE.

The PALCON, an element of MCCS, has compatibility with any USN amphibious ship and the 20-foot cells of container-ships. It will replace a spectrum of pallets and special purpose containers which are behind the state-of-the-art in dry cargo transportation. The PALCON will permit fast handling in the AOA, helping to alleviate a long standing, beach-bottleneck problem. It is durable and can be carried by helicopter. It will eliminate the periodic need to replace wooden mount-out boxes and pallets because of damage after one or two deployments. The PALCON is small enough for use

in transporting organizational equipment of combat forces in the AE.

The QUADCON is the largest container that still can be lifted by the majority of MHE (to include helicopters) in the AOA. The QUADCON gives the landing force the capability to transport larger items such as tires, stretchers and tool chests in an amphibious environment. It is designed for use by the combat service support forces and will not be transported any further inland than the LSA.

The large 8 X 8 X 20-foot commercial container provides the landing force with a large cargo capacity. It meets ANSI/IOS size and weight specifications. It is compatible with commercial container-carrying ships. Due to its size and weight, it is not presently usable in an amphibious environment. Container-handling, motor-transport and beach-mobility problems have to be solved before it can be used in the AOA.

The flatrack provides the capability to transport large irregularly shaped items to the AOA. It meets ANSI/IOS specifications and is compatible with commercial container-carrying ships. As with the 8 X 8 X 20-foot container, the same problems relative to handling equipment and motor transport in the AOA currently exist.

Table V-3 summarizes the compatibility of each container discussed with various types of shipping, MHE, motor transportation and aircraft.

Currently, the containers discussed are still in the developmental stage. It is projected that they will be in the USMC's inventory by FY84. The use of the large commercial containers will be contingent upon the solution of the container-handling, motor-transport and beach-mobility problems discussed in this study.

Generally, it can be concluded that the MCCS is a necessary system that is compatible with container-oriented technology; however, it has been ten years since the Defense Logistics Review Board recommended a container-oriented logistics system. The USMC system is still severely lacking. Containers are not available, therefore, their use in an amphibious operation today is not possible. Even if they were available, there would still be other problems that would prohibit the use of 8 X 8 X 20-foot containers and flatracks. It appears, as of this date, that it will be another three or four years before containers are introduced into the USMC's inventory. The conclusion made by a December 1977 GAO study that, "the container-oriented logistics system is severely lacking in the DOD,"³⁴ is applicable to the USMC today.

Table V-1

Supply Classes of Containerizable Material

	<u>Class</u>	<u>% Containerizable</u>
I	Subsistence	100
II	Clothing, Individual Equipment, Tentage, Organizational Tool Sets & Kits, Hand Tools, Administrative & Housekeeping Supplies & Equipment	100
III	POL - Petroleum Fuels, Lubricants, Hydraulic & Insulating Oils, Liquid & Compressed Gases, Bulk Chemical Products, Coolants, De-icing & Antifreeze Compounds, Preservatives, Additives & Coal	100
IV	Construction - Construction Material, Installed Equipment, Fortification/ Barrier Material	80
V	Ammunition - Chemical, Biological, Radiological & Special Weapons, Bombs, Explosives, Mines, Fuzes, Detonators, Pyrotechnics, Missiles, Rockets, & Propellants	100
VI	Nonmilitary Sales Items (Personal Demand)	100
VII	Major End Items	—
VIII	Medical Material	100
IX	Repair Parts	80
X	Nonmilitary Programs	75

Source: Container Requirements for Fleet Marine Forces,
p. 25.

Table V-2
Forecasted Cost of Containers

<u>Nomenclature</u>	<u>Cost</u>
Insert	\$40
PALCON	\$500
PALCON Rack	\$55
QUADCON	\$2,000
QUADCON Rack	\$325
8 X 8 X 20-foot Commercial	\$4,300*
20-foot Flatrack	\$4,800
40-foot Flatrack	\$5,800

*Current DOD regulations prohibit service ownership.
Leasing costs are estimated at \$5 per day per container.

Source: Required Operational Capability for a Family of Cargo Containers, p. 10.

Table V-3

Compatibility of Containers with Equipment Types

	Amphibious Ships	Merchant Dry Cargo Ships	Marine Corps MHE	Marine Corps Motor Transport	Marine Corps Aircraft CH 46, CH 53, and CL30
FALCON	3	3	3	3	3
QUADCON	0	2	2	2	2
8 X 8 X 20-foot Container	0	1	1	1	0
Flatrack	0	1	1	1	0

- 3 -- Compatible with all
 2 -- Compatible with most
 1 -- Compatible with limited amount
 0 -- No compatibility

VI. CONCLUSIONS AND RECOMMENDATIONS

A. INTRODUCTION

The world events of 1979 and 1980 indicate that for the United States (U.S.) there are many potential arenas for the conduct of amphibious operations. Military airlift does not have the required capacity to lift all the elements of a Marine amphibious force (MAF); therefore, sealift is still the primary mode of transportation for such a large force.

The number of United States Navy (USN) amphibious ships has declined dramatically in the last 15 years and is at an unsatisfactory level today. The procurement projection over the next 20 years indicates a continued deterioration in the number of amphibious ships. Therefore, future amphibious operations involving a large United States Marine Corps (USMC) force will be dependent upon the U.S. merchant fleet.

This study has analyzed the capability of the U.S. merchant fleet to supplement the USN's reduced amphibious lift capability. Since the current trend in the U.S. merchant fleet is toward containerization, this study has also analyzed the use of containerization as a radical change from the conventional breakbulk cargo in an amphibious objective area (AOA).

This final chapter will present the general conclusions of the author derived from this analysis. Also, included will be several recommendations that, in the author's opinion,

are necessary for the effective use of merchant ships and containerization in amphibious operations of the future.

B. CONCLUSIONS

1. History has proven that the U.S. Merchant Marine has been inadequately prepared to support military needs at the start of each war.

A development of the U.S. Merchant Marine with regard to defense needs was presented. The importance of the merchant marine in support of a military action was established. It was determined that the merchant marine was not adequately prepared to meet military transportation requirements. As a result there has been a requirement for a rapid buildup of ships to meet military logistical requirements at the start of each war.

2. Maritime support programs established by the U.S. government have not been completely successful.

Due to the problems experienced with the preparedness of the U.S. Merchant Marine at the start of each war, many maritime support programs have been established. One purpose of these programs has been to improve the U.S. Merchant Marine's capability to respond in time of national crisis. An examination of today's U.S. merchant fleet reveals that the maritime support programs have not been completely successful.

3. There are many problems with traditional sources of merchant shipping in time of military crisis.

a. The primary mission of the Military Sealift Command (MSC) is to provide contingency sealift capability for the Department of Defense (DOD). The MSC is largely dependent on the U.S. Merchant Marine for movement of military sealift cargo. Currently, the MSC-controlled fleet consists mainly of aging breakbulk ships and is deficient in the newer intermodal ships. This deficiency affects MSC's ability to satisfy critical sealift responsibilities.

b. The National Defense Reserve Fleet (NDRF) is a mothball fleet that has been established to provide reserve shipping in time of crisis. Ships in the NDRF are supposed to be capable of being activated within 30 days of callup. Due to the old age and deteriorated condition of these ships, NDRF cannot provide adequate reserve shipping within prescribed time frames.

c. Within the NDRF is a smaller fleet known as the Ready Reserve Fleet (RRF). These ships are supposed to be maintained in a state of readiness that would allow them to be put into operation within five to ten days. Testing has shown that ships of the RRF cannot provide reserve shipping within prescribed time frames.

d. The Effective United States Control Fleet (EUSC) consists of ships under foreign registry that the U.S. government can contract for defense needs in time of war. Only 25 percent of the ships in this fleet are suitable for dry cargo and the majority of them are not suitable for

containers. It would be a mistake to count on EUSC for quick availability of ships in time of war.

e. The possibility exists for an influx of foreign ownership in the U.S. merchant shipping and shipbuilding industry. The reliability of foreign owners in the U.S. maritime industry to adequately respond in time of U.S. crisis is unprecedented and questionable.

4. The use of privately-owned U.S. merchant ships in support of combat operations has several limitations.

In terms of availability, there is a lack of a sufficient number of merchant ships to keep a steady flow of imported raw materials in the U.S. and, at the same time, support combat operations. The raw materials are essential for the production of war goods. Therefore, government decision-makers will be faced with tough decisions on the use of the limited number of U.S. merchant ships available.

In addition, there are other problems. U.S. merchant shipbuilding is on the decline. Modern commercial ships that are being built are specialized. They are configured for containers and are dependent upon equipment-intensive, deep water, pier facilities. Use of these specialized ships for logistical support poses many problems for the U.S. military.

5. The design of merchant ships make them unsuitable for use in the assault echelon (AE) of an amphibious operation.

The merchant ship is designed to make point-to-point trips for the delivery of cargo as economically as possible. The USN amphibious ship is designed to deliver a USMC landing

force and its equipment to the AOA as expeditiously as possible. The difference in objectives leads to differences in manning, design and on-board equipment. Due to these differences, the merchant ships examined in this study were found to be unsuitable for use in the AE of an amphibious operation. With extensive modification, the 20-knot, general purpose cargo ship and cargo/passenger ship could be rendered suitable for employment in the AE; however, these modifications are prohibitively expensive and time-consuming. Even with extensive modification, the lighter aboard ship (LASH), the Seabee, the Roll on/Roll off (Ro/Ro) ship and the Trimariner are not suitable for use in the AE.

6. All the ships analyzed in this study were found to be suitable for use in the assault follow-on echelon (AFOE) of an amphibious operation.

With limited personnel and equipment augmentation, all the ships analyzed are suitable for employment in the AFOE. Table III-3 shows the various advantages and disadvantages of ships when employed in the AFOE. It can be concluded from the table that the ships have varying levels of usefulness. One of the major problems that surfaced is the difficulty of unloading ships in the open ocean. This problem is particularly acute with the Ro/Ro, Seabee and containership.

7. If the USN/USMC had to conduct an amphibious operation requiring the use of non-self-sustaining containerships and Ro/Ro ships, presently there would be no way to unload them.

There are many innovative concepts that offer solutions to the various stages of the cargo discharge problem without the use of a pier facility. Some of these concepts have been completely developed and others are nearing completion; however, none of them have been fully implemented as of this date. Tables IV-10, IV-11 and IV-12 set forth the advantages and disadvantages of these concepts. It will take a complement of most of the concepts listed in these three tables to unload a MAF-size force in an amphibious environment.

Private industry has submitted very promising but expensive concepts for solving the cargo discharge problem. These concepts have not been acted upon due to the high cost of development and purchase.

8. The USMC has under development the Marine Corps Container System (MCCS) designed to be compatible with amphibious and commercial shipping assets.

Commencing in 1969, DOD initiated a container-oriented logistics system for all the military services. This action resulted from the economic benefits of containerization and the trend toward containerships. The USMC currently has under development MCCS. This system is designed to be compatible with both amphibious and commercial shipping assets. Eventually, the system will also be compatible with USMC material handling equipment (MHE), motor and air transportation and all USN lighters.

From this analysis the following conclusions can be made concerning the major elements of the MCCS:

a. the pallet-size container, PALCON, is compatible with both USN amphibious ships and commercial container-carrying ships. It also is compatible with USMC MHE, motor and air transportation and USN lighters.

b. The intermediate-size container, QUADCON, is compatible with commercial container-carrying ships and all USN lighters. The QUADCON is compatible with most USMC MHE, motor and air transportation. Due to the lack of internal handling capability, it is currently not compatible with USN amphibious shipping.

c. The large 8 X 8 X 20-foot commercial container has the advantage of providing the landing force with large cargo capacity. Because of its size and weight, it is restricted from use in the AE. It is compatible with commercial container-carrying ships and can be lifted by the light amphibious container handler (LACH). It can be carried by all USN lighters. With modification, the 12-ton M127A2C trailer with M52A2 tractor is the only vehicle in the USMC inventory capable of carrying a commercial-size container. On the negative side, the 8 X 8 X 20-foot container is not compatible with USN amphibious shipping. This is due to the lack of internal handling capability and overhead constraints in cargo stowage compartments. The large size and weight of the 8 X 8 X 20-foot container prohibits its movement by USMC air transportation assets.

d. The 20-foot and 40-foot flatracks have the advantage of providing the landing force with the capability of

transporting large, irregularly-shaped items. Bridging, electronic-shelter components and water-purification systems are examples of items that would be transported in flatracks. Due to the large size and heavy weight of the flatrack and its contents, the same problems of transportability that apply to the 8 X 8 X 20-foot container apply to the flatrack.

9. There are other problems that exist before a container-oriented logistics system is possible in the AOA.

The USMC is approaching a container-oriented logistics system compatible with modern merchant ships. This system, once completely developed, will improve cargo throughput in a MAF-size amphibious operation. However, the following problems are still existent before such a system is possible.

a. Due to the lack of a soil stabilization system, there would be difficulty in transporting the large 8 X 8 X 20-foot container and flatrack on the beach and also further inland if improved roads are not available.

b. Assuming no modification, there is no motor transport equipment in the USMC's inventory capable of carrying the 8 X 8 X 20-foot container.

c. With the exception of the LACH, there are no other items of MHE in the USMC's inventory that can adequately handle the 8 X 8 X 20-foot container and flatrack.

d. There are no helicopter assets in the USMC's inventory capable of lifting a fully loaded 8 X 8 X 20-foot container and flatrack.

In summary, there are a multitude of problems that face the USN/USMC when considering the use of merchant ships and containerization in an amphibious operation. The following section is a list of recommendations that military planners need to consider if solutions to the problems highlighted in this study are to be found.

C. RECOMMENDATIONS

In order to have the required logistical support necessary for the conduct of an efficient MAF-size amphibious operation, the following recommendations are made.

1. Military planners have to establish what they need in the form of merchant shipping assets.

Specific military contingencies, such as MAF-size amphibious operation, have to be examined. The number and type of merchant ships required to support a contingency have to be determined.

2. DOD working with other governmental agencies have to take the necessary steps to ensure the availability of merchant ships in time of need.

DOD working with the Departments of Transportation and Commerce should ensure a merchant marine capable of serving as a naval auxiliary in time of war or national emergency. At a minimum, this will require lobbying for new legislation to improve the maritime support programs now in effect for U.S. shipowners and shipbuilders.

3. MSC must be heavily involved in determining contingency needs for surface container movement in amphibious operations.

The USMC trend toward a container-oriented logistics system must be supported by the appropriate type of shipping. MSC must ensure that its fleet has a sufficient number of ships that are technically capable of carrying the containerized cargo of a MAF.

4. The USN together with the Maritime Administration (MARAD) must place more emphasis on the readiness of the RRF.

Inadequate shipping and response time of the NDRF eliminates consideration of these ships for use in an amphibious operation. Therefore, the USN together with MARAD must place more emphasis on the readiness of the RRF. The ability of these ships to be operational within five to ten days must be thoroughly tested. The suitability of these ships to be used in an amphibious operation should be analyzed and every attempt to correct deficiencies should be made.

5. The USN must take the necessary steps to ensure there is sufficient supplementary equipment available for merchant ships.

In order to make merchant ships suitable for use in the AFOE of an amphibious operation, supplementary equipment is needed. This includes provisions for:

- a. communication/electronic (COMM/ELECT) equipment
- b. damage and fire-control equipment

- c. a helicopter-landing zone
- d. close in weapons system (CIWS)
- e. facilities for additional crew and members of the landing force.

The specific types and amounts of equipment needed for each type of merchant ship has to be analyzed and a source has to be provided for use in a contingency.

6. The USN must ensure a source of additional crews for merchant ships.

The additional facilities and equipment needed for the use of a merchant ship in the AFOE require additional personnel. The USN must analyze the personnel requirements for each type of merchant ship and a source for obtaining trained personnel on a short notice must be included in contingency planning.

7. The USN must complete the development of the container and vehicle discharge systems as rapidly as possible.

The innovative systems designed for the offloading of merchant ships in an amphibious environment must be expeditiously developed. Once development is completed, an all out effort should be made to procure satisfactory amounts of this equipment for the USN's inventory.

8. The offshore container-discharge concepts proposed by industry should be given the utmost consideration.

The concepts proposed by industry should be analyzed and tested. Based on results, the USN should incorporate the

procurement of the most efficient and cost-effective equipment into strategic planning.

9. The USMC should expedite the development and procurement of equipment necessary for a complete container-oriented logistics system.

This includes not only the containers currently under development, but also MHE, motor transport and soil stabilization systems.

10. DOD should reconstitute development of the HLH once being developed by the USA.

A helicopter is needed to lift a fully loaded 8 X 8 X 20-foot commercial container. The HLH, once under development by the USA but discontinued due to financial constraints, can provide this required lift capability.

The above recommendations are necessary to ensure the following:

1. the USN/USMC team can count on the U.S. Merchant Marine as a naval auxiliary in an amphibious operation,
2. the merchant ships provided will be the best equipped, safest and most suitable vessels that modern technology allows,
3. the USMC will have cargo containers available for possible amphibious operations of the future, thereby having cargo compatible with modern technologically advanced merchant ships,

4. the USN and USMC will have the equipment available in the AOA to unload cargo from ships, move it through the surf zone, unload it at the beach and transport it inland.

D. SUMMARY

Chapters II through V of this study have analyzed the capability of the USN/USMC to use merchant ships and containerization in an amphibious operation. Due to the trend of modern transportation systems toward containerization, the USN/USMC must have a container-oriented logistics system for use in the AOA. This means that shipping, container-handling equipment and motor transport assets have to be compatible. This study has shown that this is currently not the case. The low priority ranking that has reduced the USN fleet has slowed the development of a complete container-oriented logistics system for use in an amphibious environment.

A decade has passed since DOD has set forth the requirement to implement a container-oriented logistics system. Based on the current procurement projections cited in this study, it will be no earlier than 1984 before the USMC has the necessary containers in its inventory. Procurement projections for much of the container-handling equipment, motor transport and soil stabilization systems necessary for a complete system are currently not available.

In summary, it is the author's opinion that the USN/USMC team composes the greatest amphibious fighting force in the world today. However, its capability to conduct large scale

amphibious operations is severely restricted because of the mobility and cargo-handling problems pointed out in this study.

FOOTNOTES

CHAPTER I

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CHAPTER II

¹Daniel, Marshall E., Defense Transportation Organization: Strategic Mobility in Changing Times, p. 4.

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³Kendall, Lane C., "Toward a National Merchant Marine Policy," Proceedings, p. 42.

⁴Daniel, p. 6.

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⁶Ibid.

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¹⁰McDowell, p. 459.

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