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Final Report

Technical Report No. 247

POTENTIAL OF BARGES IN AMPHIBIOUS LOGISTICS

by

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10 May 1974

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Prepared for
Naval Facilities Engineering Command
under
Contract N00025-73-C-0029

2361 Jefferson Davis Highway
Arlington, Virginia 22202

SUMMARY

GENERAL

1. This report summarizes the results of a study of barges employed offshore to supplement land-based logistics in amphibious operations. The study was conducted for the Naval Facilities Engineering Command under Contract N00025-73-C-0029.

PURPOSE

2. The purpose of this study is to examine the military utility of barges in amphibious operations, develop operationally feasible utilization concepts, and identify resources needed, including types and numbers of barges and supporting equipment.

BACKGROUND

3. In the past the use of barges in amphibious operations has been precluded by the lack of a suitable means for transporting them to the objective area and handling their cargo in the beachhead area. As a result, the potential benefits of barges have not been fully realized. Supplies were retained in ships until shore logistics facilities could be developed. Demand in the early hours of the operation called for use of floating dumps in landing craft when those craft were needed for tactical purposes. When the tactical situation permitted, development of shore logistics facilities began, but those operations were characterized by beach congestion, lost cargo and slow ship discharge rates.

4. Solutions to these problems now appear feasible. The advent of the barge-carrying ship has greatly facilitated transport of barges to the objective area. Hardware now under development for ship-to-shore and over-the-beach movement of containers automatically satisfies most

of the needs of handling barges in the objective area. These two advances promise significant military logistic and economic advantages by facilitating the use of barges in amphibious logistics. The new hardware not only addresses the barge-handling problem, but also goes a long way toward easing inventory control and congestion in the beachhead early in the operation. Further, it helps solve problems of unloading the other merchant ships in the assault follow-on and subsequent resupplies. The barge has important potential in reducing waterfront construction requirements by providing covered offshore storage without tying up ships or landing craft. Although most of the new hardware will be transportable by amphibious ships, transport by barge-carrier creates additional benefits. Utilization of the LASH or Seabee would allow delivery of an entire array of components needed to provide the over-the-beach discharge of any cargo from any ship, including situations of underdeveloped or damaged harbors. Employed in this way the bargeship delivers a suit of components to replace, complement or augment assets of the landing force in discharging barge cargo, whether containerized or palletized.

FINDINGS

5. Commercial barges employed in amphibious logistic operations offer several significant advantages over conventional cargo-handling techniques:

a. Reduce required size of beachhead cargo-handling facility (page 12)

b. Reduce or postpone effort required to establish supply storage facility (page 12)

c. Reduce need to divert amphibious tactical vehicles for logistic tasks (page 17)

d. Provide a logistic system that can simultaneously handle pallets and containers (MILVAN, TRICON, MODCON, Six-Pack) or container-size loads such as the new Marine Corps shelters (page 18)

e. Increase flexibility in inventory control and warehousing of supply stocks in the objective area (page 18)

f. Save physical handling steps in the ship-to-landing force pipeline (page 18).

g. Convenient dispersal of stored explosives (page 21).

6. Barges also present several disadvantages over conventional techniques:

a. Separate the landing force from direct land access to supplies (page 21)

b. Bargeship availability (page 22)

c. Require establishment and upkeep of mooring and fenders for barge marshaling facility (page 24)

d. May require some sheltering such as mobile breakwaters in prolonged operation over exposed beaches (page 25)

e. May be limited by barge carrier and associated tug capability to launch and recover barges in heavy seas (page 25)

f. May require peacetime capital outlay in barge purchase or lease (page 26).

7. Methods of employing barges in amphibious logistic operations can be divided logically into the following three basic options that the commander may exercise as appropriate to the situation:

a. A shorefast causeway option, where a floating or elevated causeway is connected to the beach allowing land mobility vehicles to drive on and off while extending far enough offshore to allow landing craft or barges to come alongside and unload.

b. A floating crane option, where mobile or fixed cranes are mounted on causeway ferries, self-propelled causeways or in landing craft. The cranes are taken to the barge, or barges are moved to the crane, and cargo is moved from the barges onto transfer vehicles such as trailers

or trucks on pontoon causeway ferries or landing craft. At the beach, the trailers are pulled off by landing force tractors or the trucks drive off under their own power.

c. A helicopter retail lift option, where nearshore clusters are unloaded onto floating platforms, individual loads are made up and delivered by helicopter directly to the landing force customer, or helicopters lift directly from moored barges.

Any of the above options can be exercised independently or with one or both of the others. Employment of one option does not constitute an irreversible commitment, and changes in option can be made to fit a changing tactical situation.

8. Existing assets in a conventional ATG/MAB have the qualitative capability to support a nearshore barge cluster system, including anchoring, mooring, tugs, and unloading facilities. Currently assigned types of equipment are adequate for the task; however, arrangement of priorities early in the operation presents problems in actual allocation of those assets to logistical jobs. A more attractive alternative is to deliver by bargeship a separate suit of gear to handle the ship-to-shore and over-the-beach pipeline without drawdown on amphibious assets. This alternative has the added merit of allowing all the amphibious force assets to depart for other missions without penalizing the landing force mission, as would now be the case. Landing force supply stocks can grow or be withdrawn as the tactical or political situation requires, without the logistic burden of rapid and irreversible shore facility construction. Most significantly, it offers options for either containers or pallets or both.

CONCLUSIONS

9. The following conclusions relative to military utility are derived:

a. Depending on individual tactical and logistical situations, barge systems can be militarily useful and operationally feasible during any phase of the amphibious assault and subsequent operations ashore.

b. In the following applications, barges can result in substantial savings in manpower and dollar cost:

1. Terrain conditions that militate against horizontal construction in the beachhead area such as swamp, deep snow, or extremely rugged or heavily timbered surface

2. Fast moving tactical situations that call for frequent displacement of supply points

3. MAB SMLS transition to conventional logistics

4. Administrative landing in a primitive area.

c. Holding supplies in nearshore barge clusters can reduce the number of physical handling steps in the ship-to-customer pipeline by eliminating the LSA handling step.

d. A nearshore barge system is readily adaptable to mixed pallet-container pipeline and, hence, of considerable utility in the foreseeable future of mixed loads.

e. Generally speaking, the LASH is preferable to the Seabee for amphibious logistic support because the LASH population is greater, it offers easier selectivity in off-loading; and at this point appears to be less sensitive to barge launch and retrieval in higher sea states. However, complete data do not yet exist regarding the latter point.

f. Ready stocks preloaded in barges offer extremely rapid deployment or mobilization potential.

10. The following conclusions are derived relative to operational considerations:

a. Employment of barge systems in amphibious logistics should be viewed as an additional range of options rather than as an "either-or" logistic choice.

b. Using existing commercial assets, a standard, commercially configured barge carrier can greatly ease beachhead congestion in the early days of an operation.

c. A cargo-handling hardware suit transportable in a barge-carrying ship can solve the long-standing problem of unloading the assault follow-on echelon and subsequent resupply increments.

d. Environmental sensitivity of barges is generally equal to that of existing landing craft or causeways; thus, barges do not impose disqualifying new operational constraints.

RECOMMENDATIONS

11. The following recommendations are made:

a. A program of hardware development, feasibility test and engineering test should be instituted at an early date to provide a bargeship-deliverable suit of hardware that will provide a full pallet-container interface capability between commercial ships and the landing force ashore, independent of specialized Amphibious Task Force (ATF) assets.

b. Tests, such as those conducted with LASH barges by NCEL at Coronado, should be continued and accelerated, emphasizing fleet operational capability tests.

c. Specific studies of the cargo flow, inventory control and warehousing benefits and problems should be conducted and interim procedures developed.

d. Tests of the capabilities and limitations of the bargeship to launch and retrieve barges and other amphibious assets should be conducted as soon as possible.

e. Techniques for bringing greater interchangeability and compatibility between bargeship and containership delivery of outside logistic components should be developed.

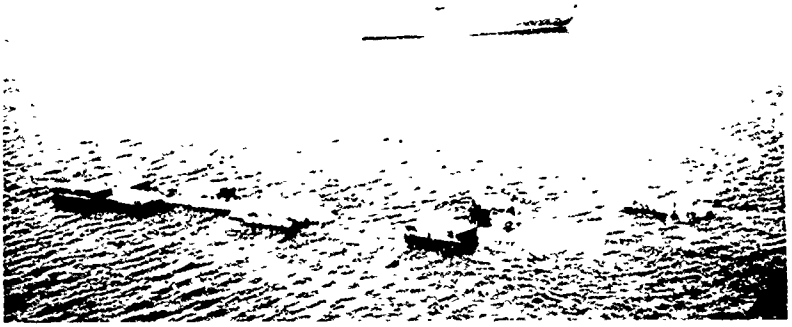
f. Factors bearing on "expedient" bargeship-transportable mobile breakwaters for shallow water should be explored.

SPECIAL SUPPLEMENT
NCEL LASH BARGE TESTS AT CORONADO

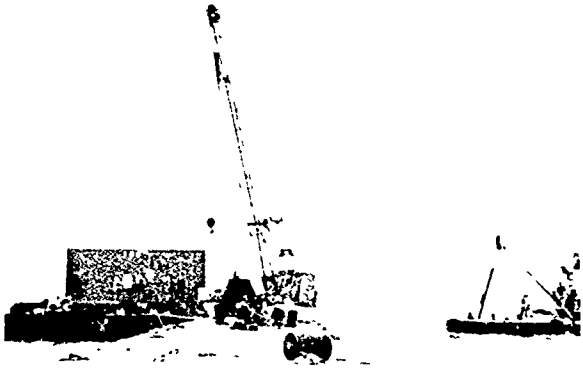
This supplement, which is supplied for reader background, summarizes LASH barge tests conducted in May, June and September 1973 in the Silver Strand area near Coronado, California, by the Naval Civil Engineering Laboratory. The tests were conducted to develop a better understanding of the capabilities, limitations and problems of using LASH barges in support of amphibious logistics operations employing existing assets and skills in the Naval Beach Groups.

Operational support for these tests was provided by Naval Beach Group ONE and Amphibious Construction Battalion ONE, Coronado, California, under the cognizance of Commander Amphibious Forces Pacific. The Third Marine Aircraft Wing provided helicopter test support. Lease arrangements for LASH barges were made through the Military Sealift Command. The program "Bargeships in Amphibious Logistics" is sponsored by the Marine Corps and the Naval Facilities Engineering Command.

Conclusions and estimates set forth in the captions that follow were derived by the Naval Civil Engineering Laboratory, Port Hueneme, California, and the Naval Facilities Engineering Command.

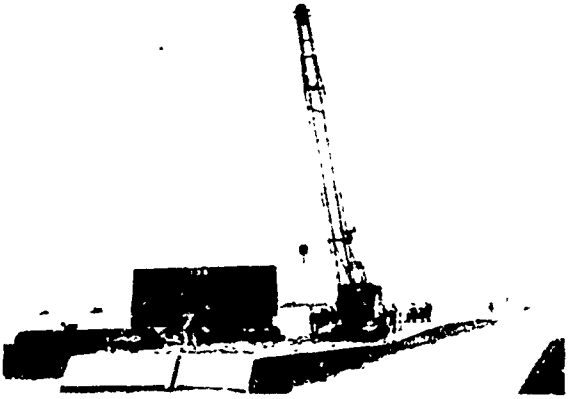


A 30-ton crane on a swing moored, 3-section causeway, 2,000 yd offshore was a satisfactory pallet discharge facility from LASH barges.

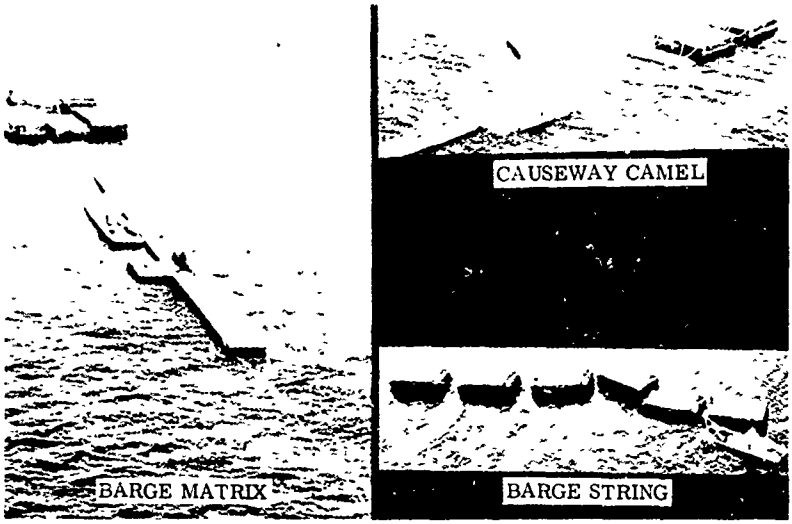


Causeway (offshore or shorefast) was adequately stable for this size crane and pallet-size loads. Transfer rates between 4 and 5 min were observed, with 5 min being typical.

Barge motions (relative to the causeway) experienced at 2,000 yd offshore were less than those experienced at 600 ft offshore on a shorefast causeway. Selective landing craft unloading from several barges to several landing craft was feasible with the above scheme.

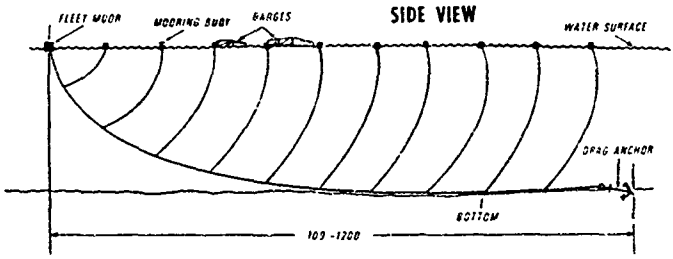


A 30-ton crane on a shorefast causeway demonstrated barge discharge 600 ft offshore. Pallet transfer rates from barge to causeway craft averaged 4 min. Barge surge motions near the surf zone made mooring alongside shorefast causeway difficult. Fendering alongside shorefast causeway was a problem as barge motions frequently tore ship type fenders loose. NCEL recommends 12- by 12-in. timbers lashed to the causeway. The same 30-ton crane in an LCU, 2,000 yd offshore, was an adequate method for pallet discharge into an LCM-8.

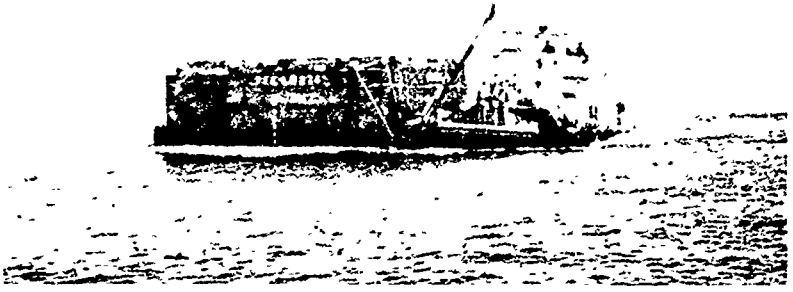


Several barge marshaling methods were tested. Of these, the swing moored "barge string" proved the most effective in terms of barge selectivity and reduced damage hazard, although it requires the most space. The barge matrix and causeway camel were ineffective because of interaction of the barges with each other or the causeway camel.

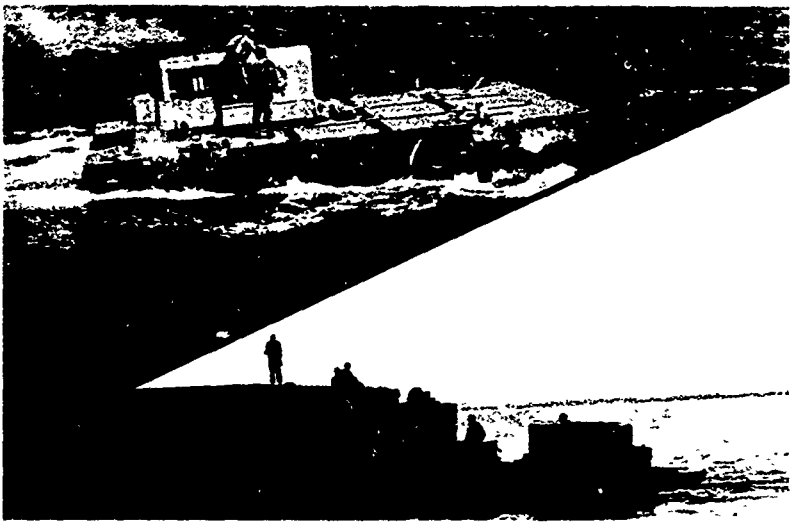
CHRISTMAS TREE MOOR



A "Christmas Tree Moor" not tested emerged as the recommended technique for future tests.

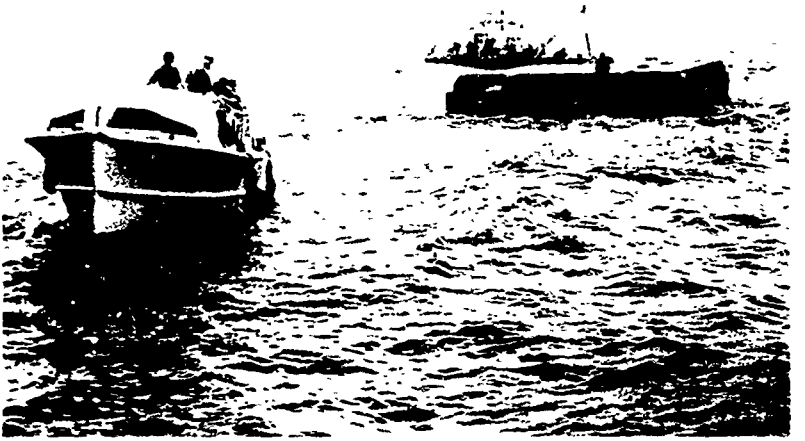


The pontoon warping tug with two 290-hp outboard propulsion units proved the most effective and versatile tug. It demonstrated all modes of towing (pull, push, breast) and was able to maneuver and control barges around causeways and other craft. A speed of 3.8 kt was obtained while towing two barges. LASH barge tow speed is increased and towline force reduced significantly by lengthening towlines (by 100 ft), because of reduced propeller backwash acting on barges. Diagonal or corner tow of LASH barges reduced towline forces, but yielded only slight increase in tow speed. Tow control was more difficult as barge skated outside propeller backwash. Pull tow of two barges in series reduced tow speed about 10% and increased towline force about 20%.



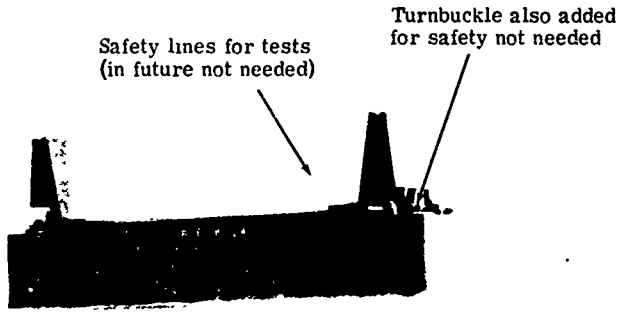
This mini-tug, assembled in 1 day using standard Navy pontoons (3 by 5 ft or 21 by 29 ft) and an 180-hp engine (Model 9D200), proved effective for all types of maneuvering and towing abreast. Pull performance was marginal under the test sea conditions. Teams of more than one can be used under adverse current and sea conditions. LASH transport of the mini-tug is feasible.

A single LCM-8 was not effective for maneuvering or towing loaded barges and had overheating problems at the slow towing speeds.

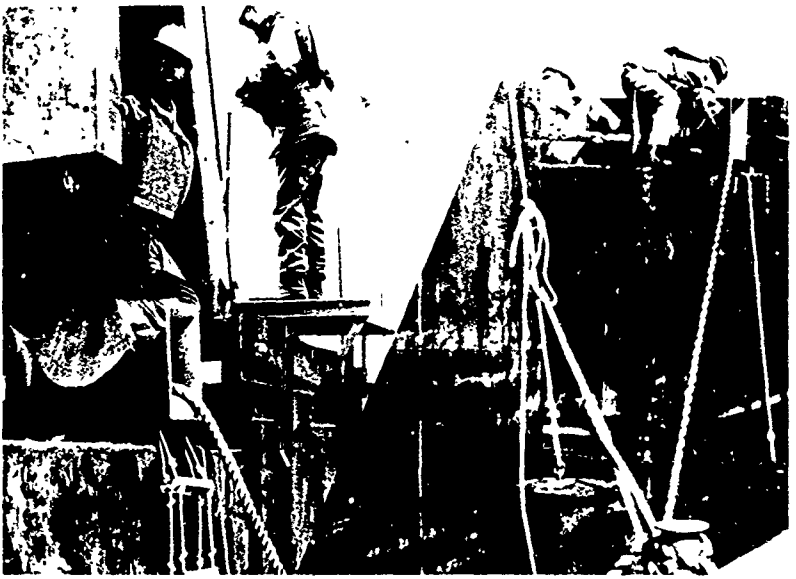


The 40-ft utility boat was marginal for pull towing empty barges in mild seas and unsuitable for loaded barge towing.

The LCU (1,000 hp) was effective in the pull tow mode and well suited to long tows. Control and maneuverability of barges for docking, however, were poor. Towing speeds, 3.8 kt and 2.5 kt respectively, were observed for single-barge and two-barge (1 full, 1 empty) tows.

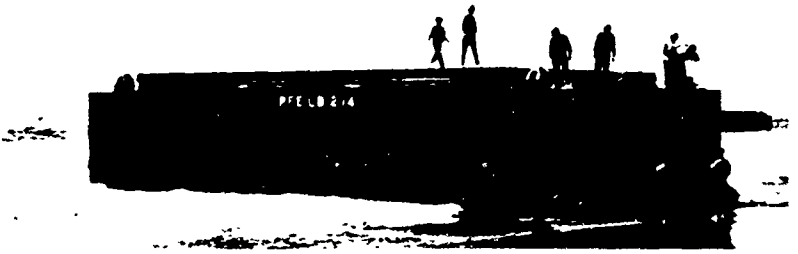


CH-53D downwash did not cause visible movement of raised hatches, which were secured with a wedge. No loads were lifted during the Coronado 1973 tests. Proper helicopter approach and preset anchors (about three 3,000-lb anchors) are recommended to keep barges from "skating." Pilot requires a securely held barge. Accordion hatch covers such as those shown above will require a very close pass by the helo, or pendants about 45 ft long. These folding hatch covers are not used by LASH ships operating in the Atlantic.



Portable hardware items were developed to facilitate operations with LASH barges and to demonstrate the concept of a temporarily installed "military kit." Portable chocks or fairlead devices inserted in the corner lifting posts reduced mooring line chafing significantly. A portable personnel walkway enabled cargo handlers to move fore and aft on the barge deck with greater safety than would be possible on the 10-in.-wide LASH sidewalls. Due to limited mooring bitt capacity on LASH barges, portable clamp-on bitts for pontoon causeways were used to provide additional mooring line capacity.

The folding type hatch covers (used in the Pacific only) can be opened in less than 5 min with a 3.5-hp gasoline-powered chain saw with a conversion kit. A 5- to 6-hp saw is recommended.



Beaching of loaded or unloaded LASH barges on sandy beaches for extended periods is feasible in surf not greater than 7 ft. Retrieval of loaded barges with warping tugs may be difficult due to sandbar buildup seaward of the barge. The barges were retrieved by the warping tug using its stern anchor and forward retrieving wire to a double drum winch. Up to three warping tugs (40,000-lb pull each) were required to free a 200-ton loaded barge left beached overnight.

TABLE 1

TRANSFER DATA ON CARGO TRANSFER RATES

Mode	Transfer Cycle	No. of Loads 1/	Avg. Rate, min 2/	Range, min
Crane on moored causeway	Light barge to causeway	6	8.9	7.2 to 10.5
	Light barge to LCM-8	6	8.0	6.4 to 10.2
	Loaded barge to causeway	5	4.4	3.1 to 5.1
Crane on shorefast causeway 3	Light barge to causeway	6	4.4	3.6 to 6.1
	Loaded barge to causeway	4	4.3	3.1 to 5.8
Crane in 1610 Class LCU	Light barge to LCM-8	6	4.7	3.7 to 6.3
	Loaded barge to LCM-8	6	4.5	3.1 to 5.6

1/ Five-ton, 8- x 8- x 20-ft container load.

2 As the tests progressed, improved load spotting techniques were developed. Initially, the raised hatch covers interfered with crane movement. Later, the 8- to 8.9-min average lift times were reduced to 4.4 min.

3 Seven-section causeway; crane on last or next to last section.

TABLE 2

PALLET TRANSFER TEST DATA SUMMARY

Mode*	No. of Loads	Avg. Cycle Time, min	Range, min	Remarks
Barge to causeway	5	3.4	3.0 to 4.0	Off-loading with taglines
Barge to LCM-8	7	3.9	3.3 to 5.3	Off-loading w/o taglines
Causeway to barge	7	3.8	2.5 to 4.7	Retrograde w/o taglines
LCM-8 to barge	4	3.0	2.7 to 3.4	Retrograde w/o taglines

*In all cases crane was positioned on a pontoon causeway of three 90-ft sections.

All loads were 2,000-lb and 4,000-lb concrete loaded pallets. Cargo "handlers" and crane operators were from the Amphibious Construction Battalion.

Amphibious construction crane is slow and not well suited for cargo transfer.

Data from NCEL's preliminary draft Technical Note, February 1974.

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I. INTRODUCTION

GENERAL

1.1 This report summarizes the results of a study assessing the operational feasibility and military utility of barges employed in near-shore waters to supplement land-based forward logistics installations in amphibious operations. The study was conducted for the Naval Facilities Engineering Command under Contract N00025-73-C-0029.

BACKGROUND

1.2 A long-standing problem in amphibious operations has been the need to build up logistical facilities ashore early in the operation when the beachhead is severely congested with troops and equipment. Commonly, in this early stage, shoreside storage facilities are not developed and landing craft, trucks, helicopters and engineer equipment may still be fully committed to tasks other than logistics. Even after the situation stabilizes and these assets begin to be available, the task of building up supplies demands a beachhead cargo capacity that is much larger than the rate of actual consumption. For a MAF-size operation, the buildup may call for a throughput capacity of 13,000 measurement tons a day,

although the consumption is only about 3,000 tons. This classical situation has stimulated interest in logistical techniques that might ease the problem and allow more convenient scheduling of resources, or even reduce the overall logistic burden during this critical period of the operation. Barges in floating or beached dumps offer considerable promise in this area by serving as a surge tank, which allows a more orderly approach to the beachhead construction.

PURPOSE

1.3 The purpose of this study is to describe nearshore barge systems and concepts that would be operationally practical and useful, to identify the resources that would make a total concept of offshore cargo discharge from barges an efficient system, and to define the amount, type and mix of cargo to be stored, along with flow rates to the beach.

APPROACH

1.4 The study addresses the problem in four steps. First, a set of force structure models are developed for typical landing forces, with their necessary shipping and other major assets. Next, the major qualitative considerations are identified and discussed. These considerations and the force structure models are then used as inputs to develop an array of individual cargo handling techniques, which are feasible in light of existing resources and major constraints. Finally, these techniques are introduced into a set of scenarios that demonstrate realistic arrangements of the individual techniques.

CONTENTS

1.5 Section II identifies the major factors that bear on the military utility of nearshore barge clusters. In Section III, the qualitative factors discussed in Section II and the quantitative factors developed in Appendix A are applied to existing amphibious doctrine, capabilities and hardware. Within this framework, various concepts are presented for dealing with barges and their cargo at the successive steps in the cargo flow. In addition, an advanced suit of hardware is postulated that promises major improvement in amphibious logistics, especially in the early days of an operation. Section IV structures these techniques into typical scenarios for Marine Amphibious Force (MAF) and Marine Amphibious Brigade (MAB) size operations and for operations that scale up from MAB to MAF size and which transition from a Seaborne Mobile Logistic System (SMLS) type to a conventionally supported operation. Section V identifies the conclusions that were derived from the study. Appendix A contains force structure descriptions, cargo types, cargo flow rates, and other significant quantitative factors. Appendix B describes a number of promising barge-handling techniques.

II. FACTORS BEARING ON MILITARY UTILITY OF NEARSHORE BARGE CLUSTERS

2.1 This section describes new amphibious logistic facility hardware under development or study by the Naval Facilities Engineering Command (NavFac) and discusses how this hardware might be employed to advantage with barge-carrying ships. Finally, the apparent advantages and disadvantages of using barges in nearshore clusters are discussed.

2.2 In spite of their potential value in the objective area, in the past barges have had only limited utility in amphibious operations because of the difficulty in delivering them. The only practical mode of transportation was the well deck amphibious ship, which meant that barges would have competed with tactical landing craft for well deck space, and therefore would have caused a sacrifice in one area to gain an advantage in the other. Now, however, barge-carrying ships such as the LASH and Seabee create a different situation, and barges in amphibious operations can be viewed in a new light.

2.3 The problem of delivering advance port facility components to the objective area is similar to the problem of barge delivery, except perhaps more acute. Examples of these components are pontoon causeways and warping tugs, which provide a vital interface between the beach and amphibious ships or commercial ships. The side load positions

in LSTs have been the only transport positions available for such components, and these positions have been suitable only for pontoon causeways, not for warping tugs or other port facility components. However, new hardware under development by the Naval Facilities Engineering Command promises significant gains by creating additional components that can also be side-loaded on the LST. In turn, the barge-carrying ship could considerably increase the utility of the new hardware and open the way for advance beachhead facilities that are more capable than in the past.

NEW HARDWARE UNDER DEVELOPMENT, AMPHIBIOUS PONTOON MODULE (APM) SYSTEM

2.4 The new hardware mentioned previously, the APM System (see Figure 2-1), uses the standard NL Pontoon module as the primary building block. To provide propulsion and A-frame power, special modules are conceived as each consisting of two pontoons. The power module will contain a water-jet propulsion unit and will be used to propel a pontoon causeway or a side-loadable warping tug. A collapsible A-frame for the warping tug and a container-size module for personnel shelter and pilot house will be developed. The winch module powering a A-frame will be recessed. All these modules will be compatible with the side-loadable warping tug concept. [1/]

1/ Naval Civil Engineering Laboratory Letter, 20 August 1973.

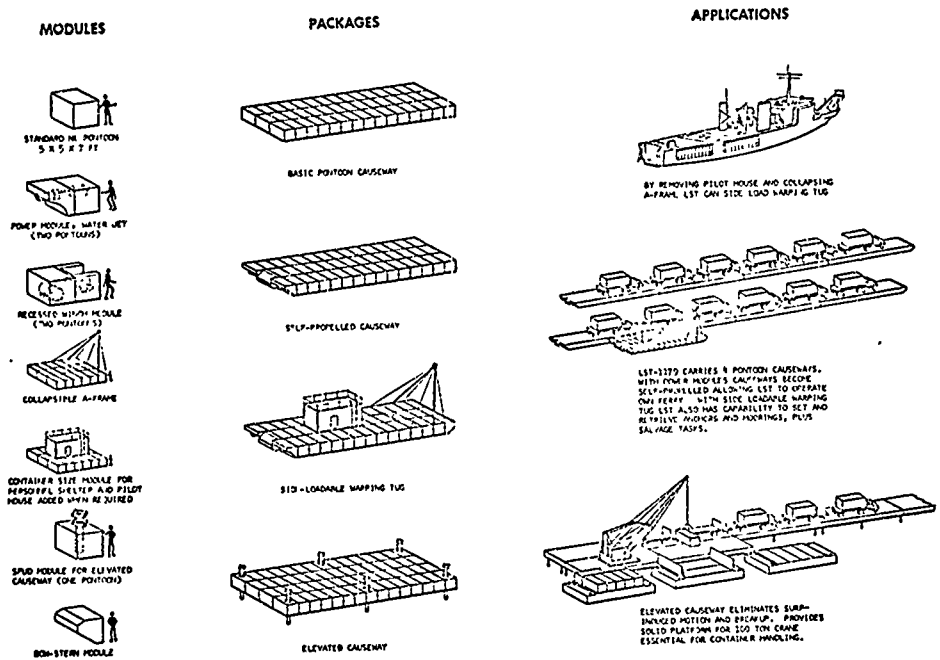

FIGURE 2.1

AMPHIBIOUS PONTOON MODULE (APM) SYSTEM

2.5 A key component of the APM system is the elevated, or jack-up causeway. This component can be floated to shallow water at the beach, then jacked up to form a pier for the operation of trucks or other land vehicles from the beach. When combined with a suitable barge-mounted or mobile crane, the elevated causeway becomes a shorefast, container-handling component that can lift containers from lighters onto trucks or trailers on the causeway. Two principal merits of the elevated causeway are: (a) it simplifies the crane problem, since it represents a stable platform, and (b) it greatly decreases the risk that the causeway will break up in heavy weather, since it is elevated above the surf and supported on firm legs standing on the bottom. The importance of this shorefast container facility in relation to barge carriers is developed in more detail later in the report.

APM SYSTEM ADAPTED TO BARGE-CARRYING SHIP

2.6 With relatively little modification, and the addition of a barge-mounted container crane, the APM system could become a complete pallet/container interface system between commercial ships and troops on the beach. Such a system could also accommodate the over-the-beach problem of off-loading the new Marine Corps shelters. Figure 2.2 shows a typical suit of such gear; this particular one is structured for the LASH ship used in support of a MAF-size operation. Like the rest of the landing force organization and equipment, however, the specific structure of the suit would depend on the task organization and the operation itself. The suit shown in Figure 2.2 contains sufficient cargo-handling equipment and lighters to move the daily needs of

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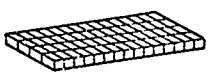
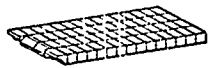
ONE LASH SUIT



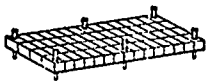
22 PONTOON CAUSEWAYS



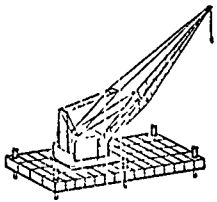
4 SELF-PROPELLED CAUSEWAYS

CAPABILITIES:

1. SHIP-TO-SHORE TRANSFER OF 3,200 TONS PER 12-HR DAY
2. DELIVERS 4+ DAYS OF SUPPLY FOR MAF
3. HANDLES MIXED PALLET-CONTAINER LOADS

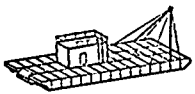


18 JACK-UP CAUSEWAYS



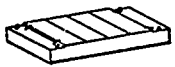
2 85-TON CRANES ON JACK-UP CAUSEWAYS

40 LASH BARGES FOR CARGO; 4 DOS FOR MAF



2 WARPING TUGS

7 12-TON CRANES



2 LASH BARGES FOR ANCHORS, BUOYS, MOORINGS, ETC.

Note: If required, LCM-8s can be carried in place of cargo barges; 2 LCM-8s occupy the space of 6 barges top-side; 10 LCM-8s maximum.

FIGURE 2.2

AMPHIBIOUS BARGE/CONTAINER LOGISTIC SYSTEM (BARCON)

a full 48,000-man MAF in combat ashore. (Supporting figures for this throughput are developed in Appendix A and elsewhere in the report.)

2.7 A LASH ship would arrive on D+5, accompanying the assault follow-on echelon. It would carry 40 standard commercial barges loaded with supplies, which amount to about 4 days of supply (DOS) for the full MAF. Its remaining 42-barge equivalent spaces would be occupied with tugs, jack-up causeways, self-propelled causeways, barge-mounted cranes, pontoon causeways, mooring gear and ground tackle. This load could be put into the water within about 20 hr after the arrival of the barge carrier, which would then be free to move on to other tasks. When unloaded, the package of gear would constitute a complete interface package to link general purpose merchant ships, self-sustaining containerships, amphibious ships or other barge carriers to the beach. The beach end would include elevated causeways and floating causeways that would accommodate roll-on/roll-off of trucks, or other land mobility vehicles. Inclusion of the crane on the elevated causeway would give the system lighter-to-truck capability for containers or container-size shelter packages. The 40 barge loads of supplies (comprising about 10% of a typical MAF resupply stockage level) might be held as covered storage, floating dumps, or else unloaded across the beach and the barges used to augment causeway ferries as lighters. Upon completion of the operation, the LASH recovers the package in about 20 hr loading time and is again free to move on to other missions where a merchant ship-to-landing force capability is required. A major share of the scenario material that follows is keyed to use of such a suit of gear.

IMPORTANT CONSIDERATIONS IN NEARSHORE BARGE CLUSTER UTILITY

2.8 Employment of nearshore barge clusters in amphibious operations has certain apparent advantages and disadvantages and raises several questions which, at this point, must be taken as disadvantages. Among the apparent advantages are:

a. Reduces required size of beachhead cargo handling facility

b. Reduces or postpones effort required to establish supply storage facility

c. Reduces need to divert amphibious tactical vehicles for logistic tasks

d. Provides a logistic system that can simultaneously handle pallets and containers (MILVAN, TRICON, MODCON, Six-Pack) or container-size loads such as the new Marine Corps shelters

e. Increases flexibility in inventory control and warehousing of supply stocks in the objective area

f. Saves physical handling steps in the ship-to-landing force pipeline

g. Facilitates convenient dispersal of stored explosives.

2.9 Employment of nearshore barge clusters has certain apparent disadvantages. Several of the major ones are:

a. Separates landing force from direct land access to supplies

b. Bargeship availability (LASH or Seabee ships)

c. Requires establishment and upkeep of moorings and fenders for the holding facility

d. May require some sheltering such as mobile breakwaters in prolonged operations over exposed beaches

e. May be limited by barge carrier and associated tug capability to launch and recover barges in heavy seas

f. May require peacetime capital outlay in barge purchase or lease.

2.10 The following paragraphs address in more detail each of the advantages and disadvantages cited above. Actual testing by the Naval Civil Engineering Laboratory (NCEL) has provided valuable empirical data and insight into the real-world problems of barge clustering. Much progress has been made in the NCEL tests, but much yet remains to be done. To that extent what appear to be advantages and disadvantages at this point remain to be validated in later actual operational tests.

Apparent Advantages

2.11 Reduces Size of Beachhead Cargo-Handling Facility. Conventional practice gives a MAF about 45 days or more of supplies on hand as soon after the initial landings as those stocks can be built up. The assault echelon arrives first with about 9 days of supply (DOS). Generally these 9 DOS will have been moved ashore by D+4 or D+5, when the assault follow-on echelon arrives with about 43 more days of supply. Since the first resupply increment of about 90,000 tons is normally expected to arrive about D+15, it is necessary to move about 43 DOS through the beachhead cargo-handling facility in the 10 days between D+5 and D+15, for an average of about 4 days of supply per day. Thus, the cargo-handling capacity of the beachhead facility must be able to accommodate that high throughput to permit the required buildup. Based on the figures developed in Appendix A, with a MAF day of supply at 3,220 measurement tons, 4 days of supply per day is almost 13,000 tons throughput per day.

2.12 On the other hand, using nearshore barge cluster techniques, the storage area builds up automatically as the barges are discharged and marshaled. The beach need have only a throughput capacity equal to the consumption rate, or about 3,220 tons per day. Figure 2.3 illustrates the magnitude of the difference in resources required for a 13,000-ton throughput capacity and 3,220-ton capacity.

2.13 Reduces or Postpones Effort Required to Establish Supply Storage Facility. The 45 or more days of supply discussed above not only have to

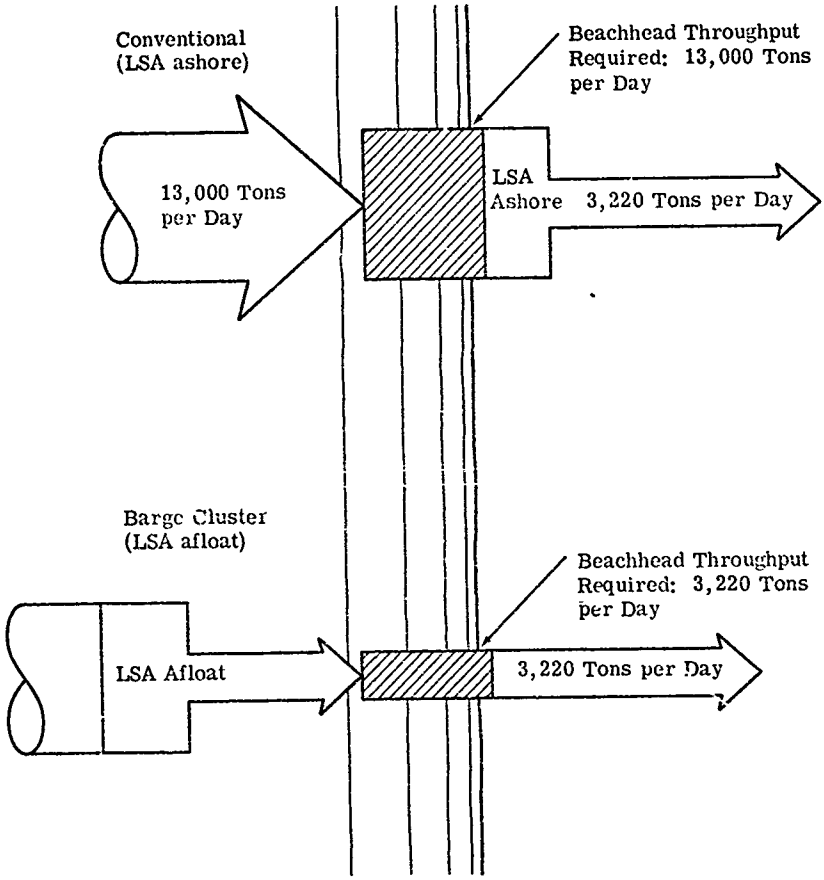


FIGURE 2.3

SUPPLY PIPELINE

(D-5 to D+15; 43 days of supply to off-load and store in 10 days)

be moved across the beach, but they must be stored somewhere until requested. This means constructing a facility that will permit stacking of pallets or containers, with sufficient separation to allow access to loads. It also requires a surface that will allow truck and forklift operation. Table 2.1 shows comparative costs for constructing such a facility and for purchasing barges to store an identical cargo package.

2.14 It is noteworthy that the overall construction cost ashore is higher than the purchase cost of the barges. In addition, the barges represent a reusable investment, where the shoreside horizontal construction must be abandoned and new facilities constructed as the tactical situation moves to other areas.

2.15 Table 2.2 shows the approximate number of man-hours required to construct the shoreside facility that ultimately would be required in the conventional operation. The approximately 2.7 million square yards of expeditionary horizontal construction require about 947,000 man-hours. This is roughly equivalent to the man-hour effort needed to clear, grub and grade 63 mi of two-lane dirt road, then clear it in front of a convoy every day for 14 days. It does not appear realistic to conduct an actual operation where all shoreside horizontal storage construction is replaced by nearshore barge clusters. However, the numbers underscore the fact that the shoreside construction effort required is very great. Therefore, any savings in that effort can pay off in making Naval Construction Battalion (NCB) or Marine Corps engineer effort available for other critical jobs. Temporary use of nearshore barges would buy time for shoreside storage construction. To the extent that shoreside storage can be shifted to nearshore barges, substantial savings in dollars and man-hours result.

TABLE 2.1

COMPARATIVE DOLLAR COSTS FOR SHORESIDE STORAGE AREA CONSTRUCTION VERSUS PURCHASE COST OF BARGES

Force Level	Required Storage Area Construction, sq yd	Cost at $14.16/ sq yd 1/	Construction Cost per Pallet	Construction Cost per Short Ton	No. of Required LASH Barge Equivalents	Cost at $56,000 per Barge 2/	Barge Cost per Pallet	Barge Cost per Short Ton
MAB (-) 30 Days of Supply								
Dry cargo (less ammunition)	64,230	909,497	88.90	209.24	27.4	1,534,400	149.99	347.94
Ammunition	161,077	2,280,850	731.04 3/	623.18	8.6	481,600	154.36	131.58
Total	225,307	3,190,347	238.97	395.33	36.0	2,016,000	151.01	249.81
MAB (1/3 MAF) 30 Days of Supply								
Dry cargo (less ammunition)	136,770	1,936,693	88.92	209.75	59.6	3,337,600	153.24	459.72
Ammunition	471,347	6,674,273	623.18 3/	623.18	29.4	1,646,400	153.72	153.72
Total	608,117	8,610,936	265.03	479.18	89.0	4,984,000	153.40	277.35
MAF, 45 Days of Supply								
Dry cargo (less ammunition)	616,230	8,725,817	88.91	206.72	267.3	14,968,800	152.52	457.55
Ammunition	2,121,062	30,034,237	623.13 3/	623.18	131.7	7,375,000	153.03	153.03
Total	2,737,292	38,760,054	261.86	479.05	399.0	22,341,000	152.69	276.16

1/ Department of the Navy, Naval Facilities Engineering Command, Design Manual, Military Construction Cost Engineering Data, NAVFAC DM-10, no date.

2/ Cost of Seabee barge estimated at $112,000 with about twice the capacity of LASH barge, thus cost figures are roughly equivalent.

3/ MAB (-) is a streamlined organization whose composition is somewhat different from the MAB (1/3 MAF) and MAF. The result is a slightly different spread of supply classes, which leads to different densities per class, and storage area costs per ton.

TABLE 2.2

STORAGE AREA CONSTRUCTION AND MAN-HOUR REQUIREMENTS FOR MAB (-), MAB (1/3 MAF) AND MAF 1/

Force Level	Measurement Tons		Short Tons		Storage Area Construction Required, sq yd		Man-Hours to Construct	
	Dry Cargo (less ammunition)	Ammunition	Dry Cargo (less ammunition)	Ammunition	Dry Cargo (less ammunition) 2/	Ammunition 3/	Dry Cargo (less ammunition) 4/	Ammunition 5/
MAB (-) 1 day of supply	341 6/	104 6/	147 6/	122 6/	2,141	5,369	1,060	1,946
MAB (1/3 MAF) 1 day of supply	726 6/	357 6/	242 6/	357 6/	4,559	15,712	2,258	5,694
MAF 1 day of supply	2,181 7/	1,071 7/	727 7/	1,071 7/	13,694	47,135	6,781	17,082
MAB (-) 30 days of supply	10,230	3,120	4,410	3,660	64,230	161,077	31,807	58,374
MAB (1/3 MAF) 30 days of supply	21,780	10,710	7,260	10,710	136,770	471,347	67,729	170,816
MAF, 45 days of supply	98,145	48,195	32,715	48,195	616,230	2,121,092	305,157	642,382

1/ Headquarters, Department of the Army, Staff Officers' Field Manual: Organizational, Technical, and Logistical Data, Unclassified Data, FM 101-10-1, September 1969.

2/ One square yard of dry cargo requires about 5.25 sq yd of storage area construction. Assuming 1 measurement ton = 1 pallet = 1.96 sq yd, each measurement ton requires about 6.274 sq yd storage area construction.

3/ One short ton of ammunition requires about 44.01 sq yd storage area construction.

4/ One sq yd of storage area construction for dry cargo requires about 0.4952 man-hours.

5/ One sq yd of ammunition storage requires about 0.3030 man-hours.

6/ See Table A.10.

7/ See Table A.4.

2.16 Reduces Need to Divert Amphibious Tactical Vehicles for Logistics Tasks. In most beach gradients the LST requires pontoon causeways to connect to the beach and discharge its cargo. Although the causeways themselves can be delivered side-loaded on the LST, warping tugs needed to set anchors, maneuver the causeways and marry them up cannot, with current hardware, be delivered in this way. Instead, well deck space in amphibious shipping is required for this transport. Since well deck space is almost always at a premium, transport of warping tugs must be at the expense of critically needed landing craft. Further, in many situations the maximum number of causeways transportable by assigned LSTs may be short of the actual requirement for ferries and LST links to the beach.

2.17 A second long-standing problem arises when the amphibious ships, with their landing craft, may be required to depart from the objective area to make a turnaround trip with additional forces or to perform other missions. In this situation there is not yet a satisfactory solution to the problem of lighterage to move landing force supplies ashore from merchant resupply ships. However, once the commercial barge carrier ship enters the picture, coupled with the new hardware under development, a highly satisfactory and relatively inexpensive solution appears. By using the barges as lighters, maneuvered by LASH- or Seabee-delivered warping tugs, mini-tugs[1/] or self-propelled causeway sections, the ATF can then depart with its landing craft without penalizing the

[1/] A mini-tug consists of a standard 180- to 290-hp outboard engine mounted on a 3-ft x 5-ft pontoon assembly, as shown in the Special Supplement.

operational effectiveness of the MAF ashore. In short, introduction of the barge carrier, augmented with new gear now under development, means that a substantial logistic load is removed from amphibious landing craft, freeing those craft for tactical missions.

2.18 Provides a Logistic System That Can Simultaneously Handle Containers and Pallets. All LASH ships have a provision for container handling, and 14 of the 20 U. S. flag LASH ships currently in operation or programmed have a container gantry installed. Thus, one of these ships, working with the new elevated causeway equipped with a container crane, gives the amphibious forces a system to move containers all the way from the hold of the LASH ship onto trucks or trailers on the beach. The system could handle both containers and pallets simultaneously, but would bring a high degree of flexibility to the logistics system with its ability to handle mixed container-pallet loads.

2.19 Increases Flexibility in Inventory Control and Warehousing of Supply Stocks in the Amphibious Objective Area. Floating stocks in near-shore barge clusters can be readily recovered and relocated in case of termination of the operation or a change in the situation. Since the stocks are already in lighters, the task of repositioning them is much easier than relocating shore-based stocks.

2.20 Saves Physical Handling Steps. By holding the barges offshore until their cargo is needed, one off/on-loading step is eliminated from the material flow path. Figures 2.4 and 2.5 illustrate two handling arrangements. In both cases the handling at the shoreside logistic support area (LSA) is eliminated. At 3,200 pallets per day required for the

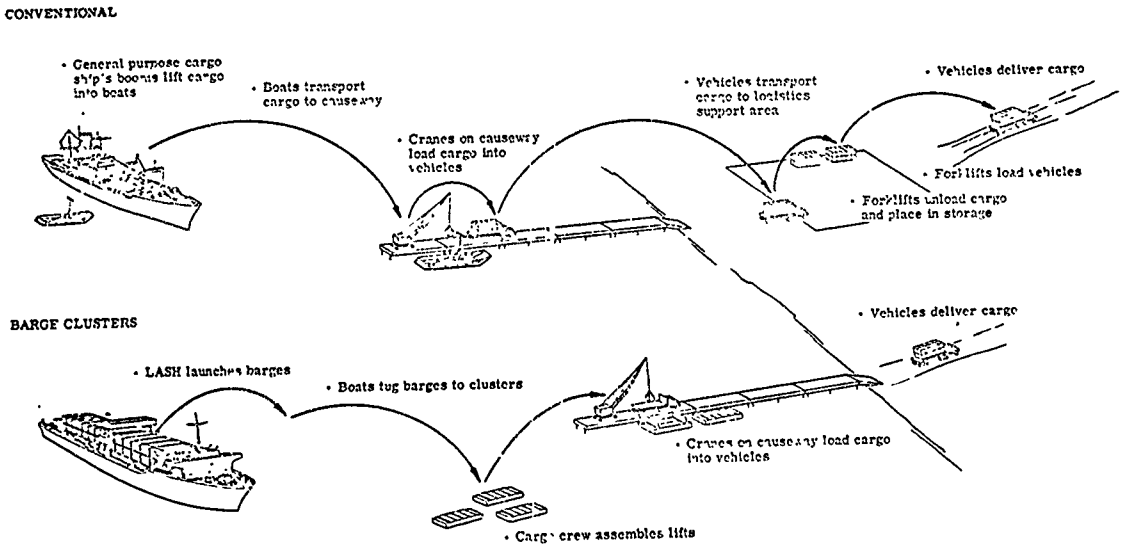


FIGURE 2.4

COMPARATIVE PHYSICAL HANDLING STEPS FOR CONVENTIONAL VERSUS BARGE CLUSTER USING TRUCK DELIVERY

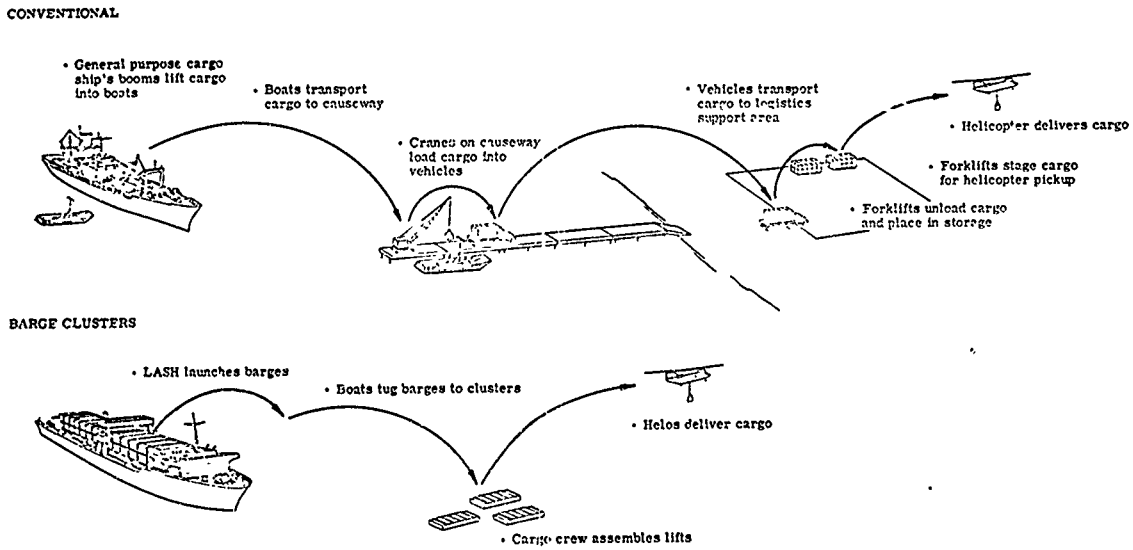


FIGURE 2.5

COMPARATIVE PHYSICAL HANDLING STEPS FOR CONVENTIONAL VERSUS BARGE CLUSTER USING HELO DELIVERY

MAF, taking each pallet as two forklift operations (one to unload at the LSA, a second to reload the pallet later when the cargo is needed), about 6,400 forklift operations daily are required at the LSA. Assuming a forklift moves one pallet every 3 min, about 20 forklifts, each working 16 hr per day, are required to perform this step at the LSA. Therefore, to the extent that a share of the resupply stocks are held in floating barge dumps, a corresponding share of the 6,400 daily forklift operations would be saved.

2.21 Convenient Dispersal of Stored Explosives. The ability to disperse individual ammunition barges throughout the offshore marshaling area represents a significant feature of barge storage. In the LASH barge over 7 ft of the 14-ft-high barge is underwater when the barge is loaded with most types of ammunition. Precise quantity-distance values for barges in different arrangements have yet to be developed, but it appears that dispersal or rearrangement of anchored barges can be done more quickly and easily than would be the case with ammunition stored in dumps ashore.

Apparent Disadvantages

2.22 Separates Landing Force From Direct Land Access to Supplies. Several factors bear on this disadvantage. Among these are the reliability of the mooring arrangements, the nature of the weather and the sea, and the general beachhead conditions. Obviously, the possibility of very heavy weather poses a more serious threat to anchored barges than to shoreside stocks. Similarly, conditions that might preclude operation of landing craft, tugs and lighters would not necessarily

preclude the operation of trucks from shoreside LSAs. On the other hand, barges anchored offshore may present a preferred alternative to shoreside storage, when the terrain is swampy, heavily forested, or otherwise difficult.

2.23 The matter of military security of offshore clusters is not clear at this point. Though barges anchored offshore offer good mortar or rocket targets, or targets for swimmers, shoreside dumps are similarly vulnerable (much ammunition and supplies in Vietnam were lost to sapper and rocket attacks). In general, however, it is expected that the degree to which the landing force commander will be willing to position his supplies offshore in barges will depend upon his confidence that the supplies can be protected and that they will be available when he needs them. Until experience has been gained to demonstrate that he can rely on floating LSAs, they will be useful mainly as temporary storage points and as surge tanks to ease the peak pressures on beachhead logistic facilities.

2.24 Bargeship Availability. This problem is not altogether unique to barge clustering; rather, it is an extension of a long-standing problem in amphibious support operations. Existing concepts depend heavily on commercial shipping to carry out amphibious operations, since amphibious shipping alone is not normally available in sufficient numbers to deliver entire landing forces. A MAF, for example, anticipates that over one-third of the landing force, the assault follow-on echelon, will be delivered by commercial shipping. In most circumstances a MAB also calls for merchant ship augmentation to compensate for a shortfall in amphibious shipping. This existing situation carries a certain military risk, since short of total mobilization, it is not possible to predict

with accuracy what types of shipping will be available at what time. In other words, it is difficult to earmark specific ships to be pulled from the merchant fleet for contingency support. A more likely situation is that the military must make do with whatever can be made available on short notice. All this means that a requirement for a special kind of commercial asset, in this case a barge carrier, is less desirable than one where any commercial ship would serve. On the other hand, a barge carrier has unique advantages that tend to balance this situation. If a barge carrier is equipped with tugs, mooring gear and other components for a ship-to-shore interface with the landing force, it is only needed for a single delivery, after which it can return to its commercial operation. Its ability to unload its entire cargo of barges in less than a day underscores this feature. In addition, having delivered this package, the landing force now has a substantial merchant ship interface without drawing down on amphibious ships or craft.

2.25 At the present time 23 barge carriers are in operation or programmed for operation in the U.S. merchant fleet by 1975. Although the number of barge carriers are projected to remain the same, the numbers of general purpose cargo ships and non-self-sustaining containerships are projected to diminish. However, the accuracy of current projections with regard to general purpose cargo ships is open to question. At the present time, the shipping industry has not yet steadied down, following the advent of the containership and the barge carrier, and the precise future of the general purpose ships is not clear. It is expected that some will be retired as unprofitable, some will be converted to other special purposes, and some will continue to be operated

on runs where the containership is not suitable. The projection of containerships and barge carriers can be made, however, with more reliability.

2.26 Estimates for 1980 [1/] put the total number of containerships and barge carriers at 82. Of this number, 23, or 39%, based on ton-mile productivity, are barge carriers. The point to be made here is that projections for the future show that barge carriers will comprise a significant share of the U.S. merchant fleet and, therefore, are reasonable candidates for augmentation of amphibious assets. The disadvantage of specialized commercial assets is therefore somewhat balanced by these other factors.

2.27 Requires Establishment and Upkeep of Moorings and Fenders for the Barge Marshaling Facility. Although conventional amphibious doctrine already calls for boat havens, pontoon causeways, boat maintenance facilities and traffic control agencies, the installation of nearshore barge clusters would increase the scope of this nearshore activity. Surface craft would likely be needed to marshal, moor and shuttle barges. Anchorages would be needed and variable weather conditions would call for special attention to the barge clusters. On the other hand, clusters would replace certain shoreside LSA cargo handling and to this extent, resources would be

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[1/] This estimate is based on ships now in the active fleet, under construction and on order, assuming a ship life of 30 yr. No attempt is made to predict future changes to shipbuilding programs that might occur through changes in market factors, trade policies, and economic or political conditions.

saved in the beachhead. These resources might logically be made available to pick up at least part of the new nearshore load. For example, quantitative examinations of the cargo-handling problem indicate that preparation of ammunition storage sites in barge clusters requires fewer man-hours than construction of shoreside LSA storage.

2.28 In sum, establishment of nearshore barge clusters will require effort not now needed in the conventional operation, but will eliminate or reduce some effort that is currently required. One expects the net effect to be that offshore clusters result in some savings in overall effort for reasons cited earlier.

2.29 May Require Some Sheltering Such as Mobile Breakwaters in Prolonged Operations Over Exposed Beaches. Mooring of individual barges, or clusters of barges offshore appears to present no problems that are substantially different from those of mooring or anchoring individual ships or craft of similar displacement. However, there are questions on the sizes and types of anchors, cables, buoys, moors and fendering gear required. What size tugs are able to maneuver what number of barges under what sea and wind conditions? Under what conditions will breakwaters be required and what type? Actual tests aimed at answering these questions have been conducted by the Naval Civil Engineering Laboratory, Port Hueneme, California, and more tests are anticipated. Data collected by NCEL thus far are used extensively in this report in those sections addressing specific concepts or operational problems.

2.30 May be Limited by Barge Carrier and Associated Tug Capability to Launch and Recover Barges in Heavy Seas. The Military Sealift Command has a continuing program to collect actual data on sea conditions

during launch and recovery of barges. Definitive data do not yet, however, exist. A major difficulty in this effort is the nature of the commercial environment in which the ships normally operate. Barge launch and recovery operations are carried out in sheltered harbors of major seaports, where sea state is not customarily a consideration. The commercial operator is more preoccupied with quick and safe barge handling than with what his upper limit of sea state might be. In past operations supporting government activities, barge discharge was stopped during conditions of 8-ft to 12-ft seas. This may present a working upper limit, but it is not certain that the same decision would have been made in an actual amphibious operation. Pacific Far East Lines has carried out loading and discharge operations with LASH ships in 5-ft to 6-ft seas with about 25 kt of wind. [2/] However, the upper limit of sea conditions for bargeship operation has not yet been definitely established and must, therefore, be considered an unanswered question and a possible disadvantage.

2.31 May Require a Peacetime Capital Outlay in Barge Purchase or Lease. LASH barge population in the 1980s is projected from 2,000 to 5,000 barges. What this number actually turns out to be will influence the requirement to lease or buy barges for military purposes. If barge population is high, and relatively large numbers of barges are available for lease on short notice, it may not be necessary for the government to buy barges, or to lease them on a long-term basis as insurance against an emergency. But if the worldwide barge population is relatively small, and most are fully occupied in commercial operation, some purchase or

[2/] Commander, Military Sealift Command, letter to COMNAVFAC of 22 January 1974.

long-term lease might be needed. Another factor in this question is the extent to which productive use may be made of barges in nonemergency conditions. For example, if one or more barge carrier ships were leased on a long-term basis for military use, and those ships could be productively employed by the government, the requirement to lease or buy barges as insurance against emergencies would be reduced. At this point it is not possible to predict with certainty the actual worldwide barge population, or to forecast government actions in the future regarding long-term lease of a barge carrier. Until more specific information becomes available on these matters, this must remain an unanswered question.

III. BARGE LOGISTIC SYSTEM OPERATIONAL CONCEPTS

3.1 In this section, the qualitative factors discussed in Section II and the quantitative factors developed in Appendix A are applied to existing amphibious doctrine, capabilities and hardware. Within this framework, various concepts are presented for dealing with barges and their cargo at the successive steps in the cargo flow. Further, the advanced suit of hardware, postulated in Figure 2.2, is introduced in several hypothetical situations.

GENERAL

3.2 Even without a specialized suit of cargo-handling gear, the barge-carrying ship brings a number of new capabilities to the amphibious operation. It is capable of discharging its own cargo with only minor exterior resources. To discharge its cargo and depart, the barge carrier requires only enough tugs to get its barges clear of the ship and secured in a temporary fashion. As identified in Appendix B, the warping tug, the LCU or LCM-8 all have certain capabilities as tugs, and are available in the conventional amphibious operation. These tugs need only be diverted from other missions briefly to reposition the barges. The general purpose ships and containerships, on the other hand, present a more demanding

problem. These types of ships require lighters for discharge of cargo. If landing craft are used as lighters, a new problem is created in what to do with the cargo in the lighters. It must either be moved ashore promptly, which calls for early beachhead preparation and additional handling there, or else the landing craft are rendered inactive by the cargo they now have embarked. Generally, it would be necessary to hold the ship in the amphibious objective area (AOA) awaiting a time when lighters can be made available and beach facilities have been sufficiently developed to allow across-the-beach unloading. Here the barge carrier can make a unique contribution, since its cargo is already packaged in lighters which, when discharged, automatically become covered storage facilities, requiring a minimum of care and attention and imposing only a brief demand for tugs.

3.3 A limitation of the barge-carrying ship, mentioned earlier, is its possible sensitivity to weather and sea conditions. Both the LASH and Seabee are designed and built as commercial vessels and are meant to operate with commercial-type port facilities, including sheltered harbors. Since it is not reasonable to expect all future amphibious operations to be conducted in sheltered waters, the ability of the barge carrier to launch its lighters in higher sea states becomes an important military consideration. The current data collection and the engineering analyses being conducted by the Naval Civil Engineering Laboratory will broaden the base of knowledge. In this regard, however, the key question is not whether barges can be launched offshore in extreme sea conditions, since this might also halt all small craft operation and sharply

curtail any amphibious operation. A more pertinent question is whether the ships can launch barges in the same conditions that landing craft can operate or, if not, at what point barge launch is not feasible but landing craft operation can continue.

3.4 It is not essential at this point to isolate the particular extreme set of sea conditions that prevent barge launch. Even without this information, it is useful to examine in detail the military and operational impact of the barge carrier in conditions where it is able to launch barges. There are many conditions where operation is entirely feasible and in those conditions the barge ship opens up a number of unique military possibilities that were not present before. This portion of the report addresses barge logistic system operation in those situations. The material presented below on barge launch and retrieval, clustering, towing and mooring techniques was developed from the more detailed information provided in Appendix B.

BARGE CARGO DISCHARGE

3.5 The following paragraphs identify three major logistic options for unloading barges and/or moving their cargo across the beach. The three options are discussed and the relative advantages and disadvantages of each are presented. The techniques are based on: use of a shorefast causeway, either floating or elevated; a floating crane, mounted on a causeway ferry or in a landing craft; and helicopter retail unloading where the cargo is moved directly from the barge to the landing force

customer. The three are not mutually exclusive and any single option, or any combination of options might be exercised, depending on the local situation.

Shorefast Causeway Option

3.6 Within the framework of existing hardware, that is, assuming a LASH cargo-handling suit is not available, pontoon causeways, side-loaded on LST, would be delivered to the objective area. These are launched into the water, assembled into a floating causeway pier, beached and anchored. If the LST is to be used as a floating crane platform, or if the LST's own cargo is to be unloaded, the bow ramp of the ship is lowered onto the causeway and the vehicles are driven ashore. In this arrangement, barges are tied up alongside the ship and unloaded as shown in Figure 3.1. The ship's booms or a mobile crane would be used to lift cargo from the barges onto trucks or flatbed trailers on the main deck, or through the hatch on the main deck onto trucks below, which are then driven ashore over the causeway.

3.7 In situations where the causeway is used only as a barge unloading terminal, the causeway is employed as shown in Figure 3.2. A small self-propelled crane, of the type organic to Shore Party units, Naval Construction Battalions or Marine Corps engineers, is used to unload palletized cargo from barges that are tied alongside. The crane lifts the cargo directly onto truck or trailers. The causeway might be configured with a T-head at the end, which allows two cranes to operate simultaneously, while providing a working area and vehicle turning and maneuvering area. The length of the causeway is determined to some extent by the draft required for a fully loaded barge (about 9 ft in the case of a LASH barge)

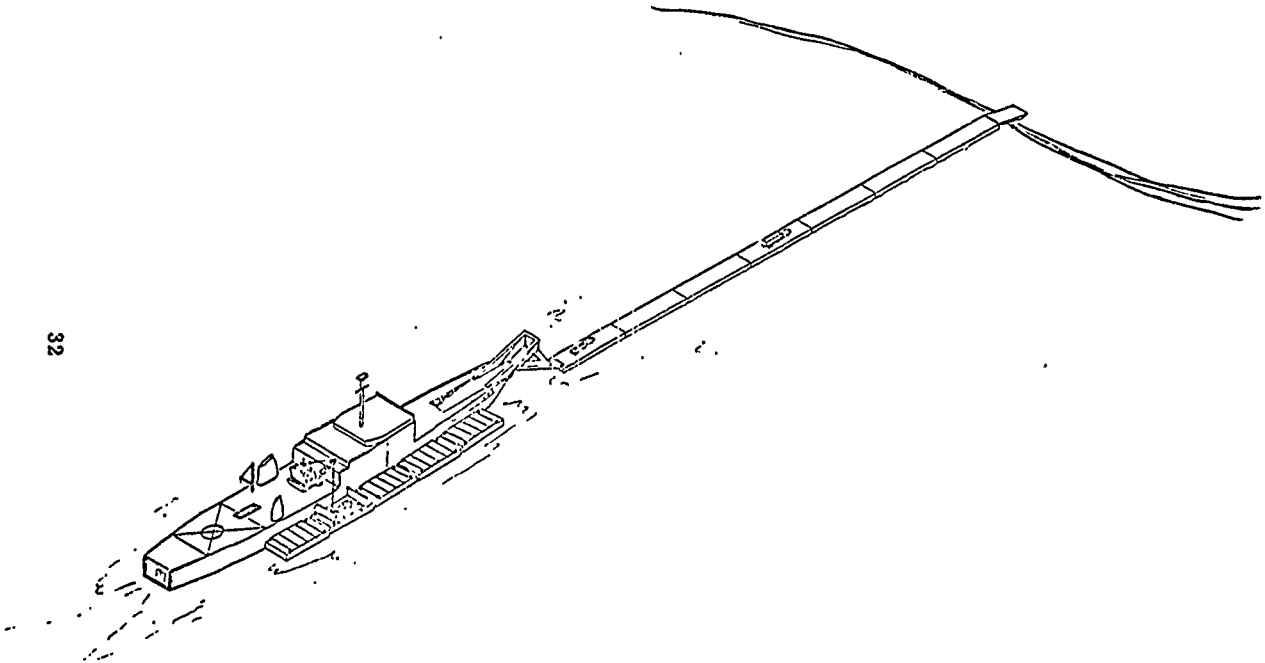


FIGURE 3.1
LST USED IN CARGO DISCHARGE FUNCTION

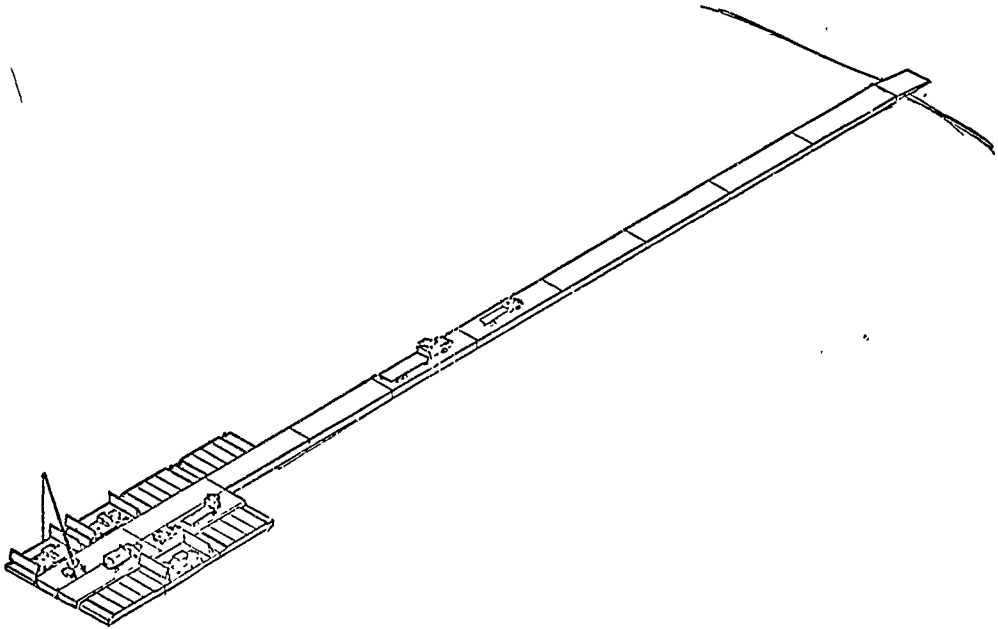


FIGURE 3.2

FLOATING CAUSEWAY PIER WITH SMALL CRANE FOR LIFTING PALLETS FROM BARGES

and the distance offshore that would permit the work area to be clear of the surf zone. In addition, however, the length of the floating causeway will be determined by the beach gradient and the LST draft, which is about 16 ft at the stern.

3.8 In those situations where a barge cargo-handling suit is available, a high capacity container crane mounted on elevated causeways would be included, along with the elevated causeway sections to build up an elevated pier. An example is shown in Figure 3.3. A principal role of the elevated causeway is to provide a stable platform for operation of the large container-capable crane and for vehicle roll-on/roll-off. Landing craft and barges would be brought alongside, but it is not envisioned that the pier would be sufficiently heavy to accommodate ships alongside. The addition of dolphins, however, and employment of spread moors for a ship moored close by could extend the causeway's capability to unload a ship. The installation of dolphins would normally be considered part of an advance base development effort, occurring after the completion of the amphibious operation.

3.9 In initial installation, causeway sections would be floated into place with warping tugs or other tugs as shown in Figure 3.3. The sections would then be elevated to form the pier. This facility, with a T-head (see Figure 3.4), would allow installation of two cranes, one large and one small, and could thus simultaneously accommodate one pallet and one container station or two pallet stations. Crane cycle time and lift rate for a crane mounted on a floating platform and a fixed platform are given in Table 3.1. Table 3.2 shows the crane-hours required to lift 1 day of supply for three different force sizes, in several different cargo and crane configurations. Table 3.3 translates these

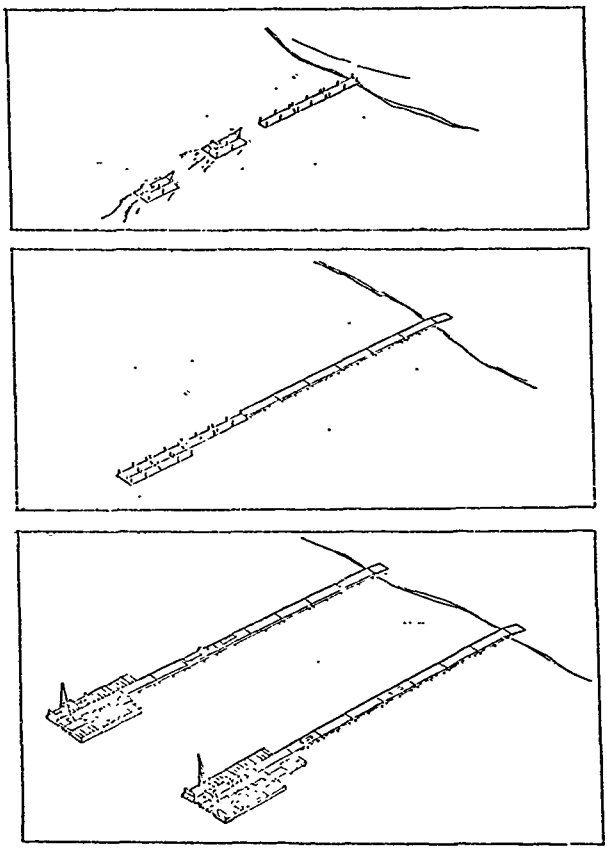


FIGURE 3.3

BUILDUP OF ELEVATED CAUSEWAY PIER AND UNLOADING OPERATIONS WITH HEAVY CRANE FOR LIFTING CONTAINERS

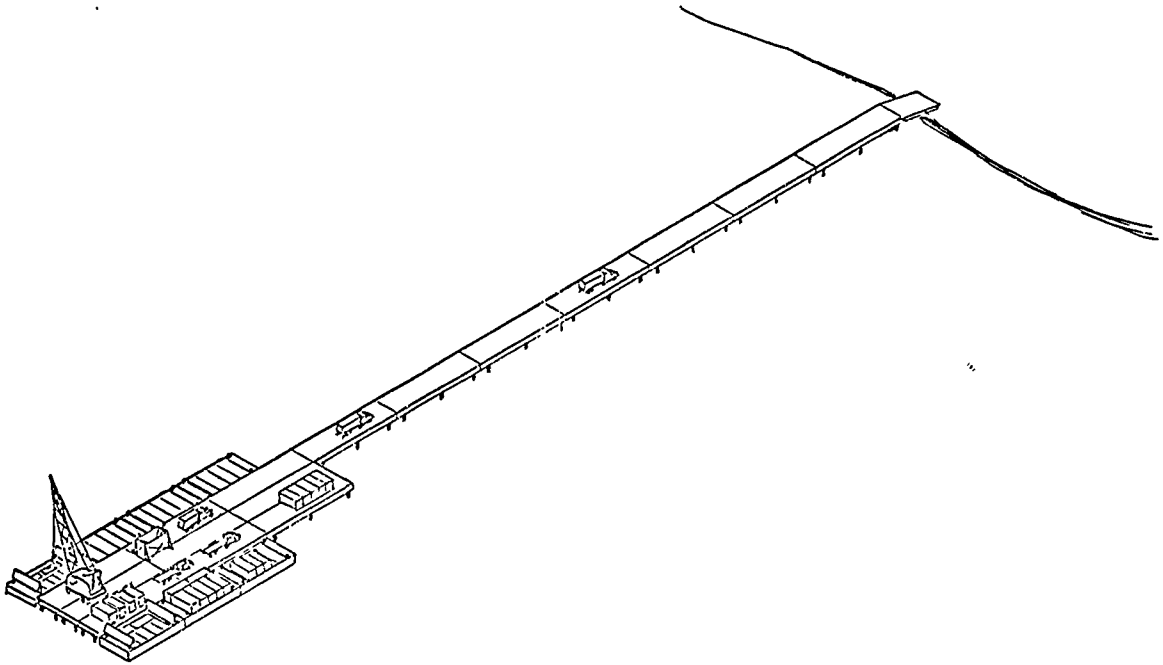


FIGURE 3.4

ELEVATED CAUSEWAY PIER IN OPERATION LIFTING CONTAINERS FROM BARGES AND PLACING THEM ON TRUCKS

TABLE 3.1

CRANE LIFT CYCLE TIME AND LIFT RATE

Operation	Cycle Time	Rate
Crane on elevated pier		
Containers*	6 min/container	10 containers/hr
Pallets	4 min/2-pallet lift	30 pallets/hr
Crane on floating causeway or LCU		
Pallets	6 min/2-pallet lift	20 pallets/hr

*Descriptive Statistical Summary, OSDOC II, Table, page 8.

TABLE 3.2

DAILY CRANE-HOURS REQUIRED TO LIFT
1 DAY OF SUPPLY

Operation	MAF	Heavy MAB (1/3 MAF)	Light MAB
Crane on floating causeway or LCU, all palletized	163	54.2	22.2
Crane on elevated causeway			
37% containerized cargo			
Containers	6.2	2.1	0.9
Pallets	68.3	22.8	9.3
Total	74.5	24.9	10.2
18.5% containerized cargo			
Containers	3.1	1.0	0.4
Pallets	88.3	29.4	12.1
Total	91.4	30.4	12.5
All palletized cargo	108	36.1	14.8

TABLE 3.3

NUMBER OF CRANES REQUIRED FOR CARGO LIFT OPERATIONS

Operation	MAF*	Heavy* MAB (1/3 MAF)	Light* MAB
Crane on floating causeway or LCU, unloading pallets	13.6	4.5	1.9
Crane on elevated causeway			
37% containerized cargo	6.2	2.0	0.8
18.5% containerized cargo	7.6	2.5	1.0
All palletized cargo	9.0	3.0	1.2

* Figures assume 12-hr work day for cranes. Detailed development of force structures and resupply profiles for these three typical forces are presented in Appendix A.

data into total number of cranes requ red for the various arrangements and force sizes, if all dry cargo for a full day of supply is moved by crane. Since other options would probably also be exercised simultaneously, the numbers presented in Table 3.3 constitute upper limits, and actual requirements would likely be somewhat less than the figures shown.

3.10 The shorefast causeway option, either floating or elevated, has several important advantages:

a. It allows economical use of assets. Barges, rather than landing craft, are used as offshore storage points and surface transfer vehicles. Trucks are employed in land transport rather than as transfer vehicles in landing craft. cranes can be conveniently used in the cargo terminals, and propulsion units such as landing craft are not tied down in loading and unloading operations.

b. It can be employed on a limited scale with existing assets.

c. It is well suited to wholesale cargo movement enroute to a shoreside LSA.

d. It is directly compatible with elevated causeway hardware, which facilitates use of high capacity cranes, easier unloading of barges and other transfer vehicles and is less sensitive to sea conditions than a floating causeway.

3.11 The shorefast causeway option also has several disadvantages:

a. In the case of the floating causeway, cargo handling is sensitive to conditions in the surf zone, and it requires continuous tending of anchors and causeway hardware.

b. It requires preparation of a beach terminal for cargo handling.

c. Installation of elevated causeways will require effort by Navy Construction Battalions. 1/

Floating Crane Option

3.12 In this option, cargo is unloaded offshore from the barges by cranes mounted in landing craft, on causeway sections, or, when available, on self-propelled causeways. The cranes are moved to the barges which are either clustered or tied up alongside moored service platforms. Flatbed trailers or trucks are loaded in landing craft or onto causeway ferries at the beach and taken alongside the floating crane, which then unloads the barges onto the trailers. After the trailers are loaded, the landing craft or ferries are beached, the loaded trailers are moved ashore and empty trailers are moved aboard. Two typical arrangements are shown in Figure 3.5.

1/ Although the magnitude of the effort is not great, it does represent an additional task for the NCB personnel at a time when they are traditionally hard pressed. NCEL estimates that 12 men will require about 3 hr to elevate each causeway section, on the average, with a slightly longer time to elevate the first section.

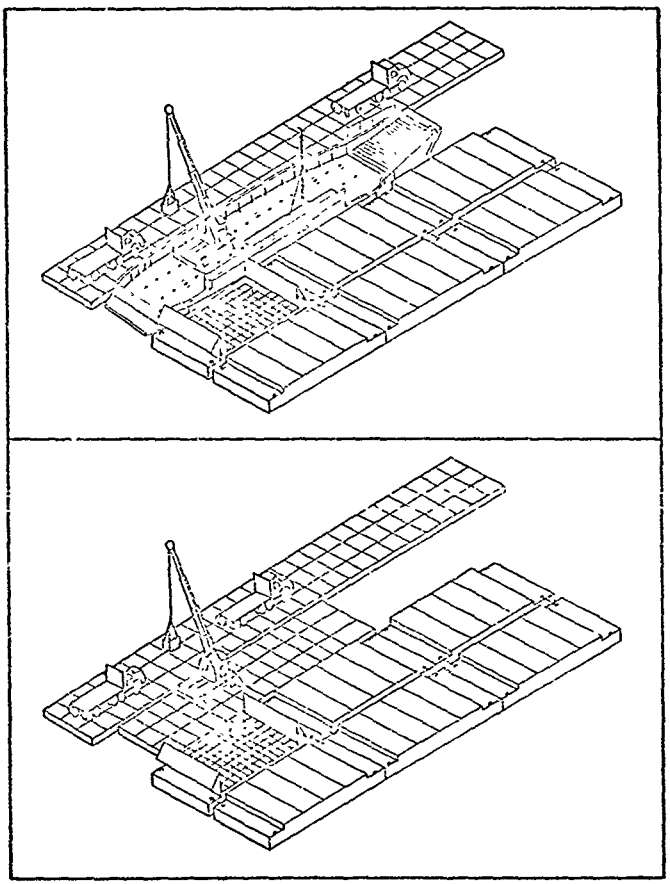


FIGURE 3.5

PALLET CRANE MOUNTED ON LCU AND
ON PONTOON CAUSEWAY

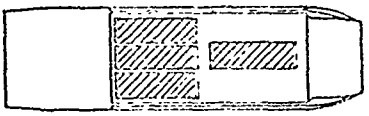
3.13 Flatbed trailers used in the study are the M18-A1, the M127-A2C and the M172-A1. A typical loading configuration is shown in Table 3.4 and a plan view of these configurations is shown in Figure 3.6. Cargo shuttle operation cycle times are given in Table 3.5. Table 3.6 shows cycle times, rates, and craft-hours for each force, and each landing craft, calculated on the basis of number of pallets loaded onto a landing craft, and the number of trailers to be driven on and off the landing craft. An assumption of 12 hr average service time per day was made to construct Table 3.7, which identifies the number of each craft necessary to move 1 day of supply. Interestingly, the LCM-8, although much smaller and normally available in much greater numbers than the LCU, is about 80% as effective as the larger craft in this specialized role. This is because the productivity of the craft at short distances is primarily a function of loading and unloading time and the use of the smaller craft results in a more balanced flow of vehicles to the shore.

3.14 The primary advantages of the floating crane option include:

a. It is expected to become available early in the normal sequence of events in an amphibious operation. As soon as the beach has been sufficiently developed to allow rolling stock to drive out of landing craft and across the beach, floating cranes could begin to unload barges and move cargo ashore. Although floating or elevated causeways might also be installed early in the sequence, under normal conditions it is expected that the beach could be made trafficable for vehicles before causeways could be installed.

LCM-6 with one M118A1 semitrailer

LCM-8 with one M127A2C semitrailer



LCU 1466 class with four M127A2C semitrailers

LCU 1610 class with five M118A1 semitrailers

Pontoon causeway ferry with two M172A1 semitrailers

FIGURE 3.6

TYPICAL FLATBED TRAILER CONFIGURATION IN VARIOUS LANDING CRAFT AND PONTOON CAUSEWAY FERRY

TABLE 3.4

TYPICAL CONFIGURATION OF FLATBED TRAILERS IN LANDING CRAFT AND PONTOON CAUSEWAY

Craft	Trailers	Pallet Capacity
LCM-6	(1) M118A1	12
LCM-8	(1) M127A2C	16
LCU-1466	(4) M127A2C	64
LCU-1610	(5) M118A1	60
Pontoon causeway	(2) M172A1	40

TABLE 3.5

BARGE-TO-SHORE SHUTTLE CYCLE TIME

Operation	Time
Offshore loading	6 min/2-pallet lift
Craft handling	5 min
Transit to shore	5 min (500 yd)
Craft handling	3 min
Offloading cargo	4 min/trailer
Onloading trailers	4 min/trailer
Craft handling	3 min
Transit to barge	5 min (500 yd)
Craft handling	5 min

TABLE 3.6

LANDING CRAFT CHARACTERISTICS

Craft	No. of Pallets	Cycle Time, hr	Rate, pallets/hr	Craft Hours		
				MAF	Heavy MAB (1/3 MAF)	Light MAB
LCM-6	12	1.16	10.3	315	105	43
LCM-8	16	1.36	11.8	276	92	38
LCU-1608	64	4.16	15.4	211	70	28
LCU-1610	60	4.1	14.6	222	74	30
Pontoon causeway	40	2.7	14.8	219	73	30

TABLE 3.7

CRAFT REQUIRED TO MOVE 1 DAY OF SUPPLY

Craft Type	MAF	Heavy MAB (1/3 MAF)	Light MAB
LCM-6	26.3	8.8	3.6
LCM-8	23.0	7.7	3.2
LCU-1466	17.6	5.8	2.3
LCU-1610	18.5	6.2	2.5
Pontoon causeway	18.3	6.1	2.5

Note: Numbers of craft are based on the assumption that each craft operates 12 hr per day.

b. Rather than using relatively expensive helicopters or landing craft as primary transfer vehicles, the floating crane option could be employed using relatively inexpensive causeway ferries and warping tugs. In the same way, this option would not draw down on tactical mobility vehicles for the logistical task.

c. The option could be exercised now using existing assets (warping tugs, pontoon causeways, trucks, trailers, etc.).

d. No cargo handling would be necessary at the beach, since loaded trucks would be ready to roll off and go directly to customers or to shoreside LSA facilities for unloading.

3.15 This option also has several substantial disadvantages:

a. It requires suitable beach conditions or preparation, such as gradient, stable soil, and trafficability.

b. It is sensitive to sea conditions, since relative motion of barges and cranes might slow the cycle times of crane operation.

c. Existing Navy and Marine Corps cranes are generally optimized for construction rather than cargo handling and tend to be slow and larger than required for barge unloading.

d. It requires more craft and trucks than the shore-fast causeway option to move a similar amount of cargo.

e. Even with a LASH cargo-handling package, this option would not be readily adaptable to unloading container-size loads from barges onto trucks.

Helicopter Retail Lift

3.16 This logistic option entails use of helicopters to unload cargo out of barges and deliver it directly to the customer on a "retail" basis. This option can be made available very early in the operation; in fact it can be exercised even before any landing craft are in the water, since helicopters can lift cargo out of the top layer of barges on a barge-carrying ship even before the ship has actually reached the AOA. This early use of the option could have a practical application in cases where the scheduled flow of events in the beachhead has been interrupted: for example, a situation where a heliborne force has been landed at inland landing zones and conditions in the immediate beach area are temporarily holding up landings there. In such a case, the ability to augment the ability of amphibious ships to stage heliborne resupply might be a valuable asset.

3.17 The helicopter retail lift might also be very valuable in cases where emergency or unexpected conditions call for rapid movement of cargo to points not originally anticipated. An example might be loss of an ammunition dump ashore, which must be reconstituted rapidly.

Additionally, this option would be useful in situations where the commander may prefer to minimize shoreside facilities either for political reasons or because of terrain conditions. In these situations, it would appear that helicopter retail lift of supplies could be carried out for an indefinite time period, and for relatively large (MAB-size) units.

3.18 Figure 3.7 shows a facility configuration capable of supporting a light MAB. (The "light MAB" used here, and described in more detail in Appendix A, consists of about 9,000 troops.) It has streamlined combat service support, only limited rolling stock and no organic fixed-wing air. Generally, it looks like a regimental landing team (RLT) type force that a MAF might earmark for heliborne operations, or an SMLS-organized force. That force requires about 445 pallet-equivalents of resupply per day on a sustained basis. The arrangement shown in Figure 3.7 can accommodate that throughput.

3.19 The configuration in Figure 3.7 entails the use of a platform made up of nine pontoon [1/] causeway sections. Two cranes are positioned at one end such that they can unload two barges simultaneously. With this arrangement, cargo barges would be brought alongside the platform, and cargo would be lifted by cranes onto the platform where it would be broken down. Individual retail customer orders would be made up and moved by forklift to the other end of the platform for pickup by helicopter. Referring to Table 3.2, a light MAB is expected to require about 22.2 hr of floating crane operating daily to sustain that unit's needs. Operating on

[1/] Recent tests by NCEL and ACB-1 demonstrated the feasibility of assembling such a platform 15,000 yd offshore.

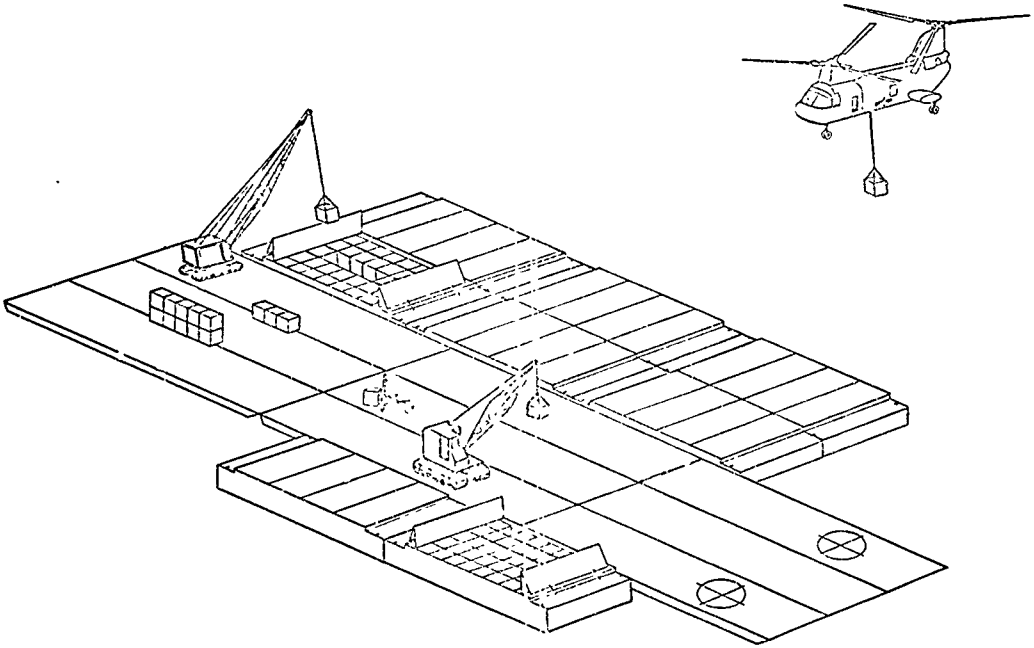


FIGURE 3.7

HELICOPTER RETAIL LIFT ON CAUSEWAY WORKING PLATFORM

a 12-hr day basis, two cranes would provide 24 hr of crane operation daily, which is more than adequate, with about 100% safety factor, assuming the facility could shift to full-period operation in emergencies. A daily consumption of 445 pallets represents about 1.2 LASH barge equivalents per day, or about 6 barges every fifth day, which is a modest tug and barge-handling requirement.

3.20 Helicopter retail lift appears to be an ideal technique through which to transition from an SMLS-oriented operation, of MAB size for example, into a larger size operation. The shift of retail support from the ships of the ATG to offshore retail issue platforms is not a major change and should not disrupt an orderly operation. Yet the shift of the support job from ships to nearshore clusters would free the amphibious ships to depart the AOA, even before the beachhead might be prepared to pick up the entire storage and handling problem. As soon as this could be accomplished ashore, the function might then shift from the nearshore facility to the shoreside one, or it might continue to operate on a retail issue basis if the situation ashore militated against shoreside logistical facilities.

3.21 Although the helicopter retail lift option has a number of very attractive features, it also has a serious shortcoming: it calls for fairly extensive use of helicopters for logistic tasks, when those same aircraft might be more urgently needed for tactical mobility of troops and equipment. However, use of the helo retail option must be considered as an addition to the list of options available to the commander.

He may decide that helo movement of a certain unit at a certain time is more important than helo resupply of another unit. On the other hand, if he considers that resupply of a certain unit is of overriding importance, helicopter retail is an option that he is free to exercise. In short, like the other options available in nearshore barge operations, it is not an either-or proposition, where use of one option denies use of others. The commander may exercise as much or as little of one or another option as he sees fit.

3.22 In sum, the helicopter retail option embodies several significant advantages:

a. It becomes available very early in the operation, even before H-hour in extreme cases.

b. It is independent of beach gradient or other beach interface problems.

c. It can be employed using only existing assets, although configured in a manner not now commonly used in conventional operations.

d. It is capable of high priority cargo movement, such as reestablishment of ammunition dumps, when surface means are too slow, or when overland movement to the desired point is not feasible.

3.23 This option also has several significant disadvantages:

a. It draws down on available helicopter sorties, which, in past campaigns, have invariably been in short supply.

b. It requires load preparation in the helicopter pickup zones and calls for relatively sophisticated inventory and requisition management procedures that are not desirable in a fast moving combat situation.

c. If customer load preparation at pickup points is not desirable, the option requires that barges be preloaded and cargo possibly prenetted for retail distribution.

d. Relative sensitivity of helicopter lift from barges or floating platforms is not known at this time, severe problems may exist, or the operation may be manageable. In either case, however, helicopter resupply must be considered more sensitive to weather and sea conditions than truck movement from shoreside dumps.

e. The helicopter is a very expensive and vulnerable vehicle to use as an airborne truck, and it rarely is cost-effective for routine resupply operations. However, in cases where there is no other way to move supplies in response to a priority or emergency situation, cost-effectiveness is not the primary consideration.

f. Unless the CH-53E is available, this option is not suitable for container handling. This is a mixed disadvantage, however, since one might expect

that forward area customers who must have helicopter-delivered resupply may not desire resupply delivered in container-size loads.

Summary

3.24 Table 3.8 summarizes the advantages and disadvantages of the three options discussed above. These options are not mutually exclusive and any can be used in combination with any other. In this way, advantages of one option might be used to compensate for disadvantages of another in the overall scheme of operations.

TABLE 3.8

COMPARISON OF SHIP-TO-SHORE CARGO OPTIONS

Ship-to-Shore Cargo Options	Advantages	Disadvantages
I. SHOREFAST CAUSEWAY (Barge moored offshore. Crane mounted on causeway at beach. Barge tugged alongside. Crane transfers pallets from barge to truck. Truck delivers to customer. Barges and trucks are transfer vehicles.)	– Economical (barges serve as storage locations and as water transfer vehicles, trucks involved in land transport but not in water transport, cranes serve terminals, propulsion units not tied up in loading/unloading operations) – Can use fixed crane platform (elevated pier—no induced motion and less sensitive than floating platform to sea conditions) – Workable with existing assets – Well suited for wholesale cargo movement to LSA	– Requires cargo handling in beach/surf zone – Requires time to prepare beach terminal for cargo handling – Floating platform is sensitive to surf conditions – Elevated platform (under development) can be clear of moderate surf
II. FLOATING CRANE (Barge moored offshore. LC with crane and truck moves alongside. Crane transfers pallets from barge to truck. LC delivers truck to beach. Truck delivers pallets to customers. LC and trucks are transfer vehicles.)	– Second Best Responsiveness: Option available when landing craft/beach interface is established for RO/RO operations – Uses relatively inexpensive displacement craft and trucks – Workable with existing assets – No cargo handling necessary at beach (sea-to-land transfer via RO/RO)	– Requires suitable beaching conditions (gradient, stable soil, traffic control, etc.) – Sensitive to sea conditions (motion of cargo barge and crane platform) – Existing Navy/Marine Corps cranes not designed for this mode of operation (large, heavy, slow) – Landing craft and truck utilization degraded by trucks transiting with cargo – Moderate cost cargo movement (requires more craft and trucks than Option III for given cargo throughout) – Not readily suitable for container handling
III. HELO RETAIL LIFT (Barge offshore. Helo removes pallets from barge and delivers directly to customer. Helo is transfer vehicle.)	– Best Responsiveness: Option available on arrival of LASH in AOA (even before barges are launched) – Independent of beach gradient and other beach interface problems – Uses existing assets – Capable of cargo movement when surface movement is not feasible or desirable	– Draws on helicopters needed for tactical mobility – Requires unit load preparation for helo external lift or requires barges loaded for direct customer distribution – Relative sensitivity to sea conditions unknown – High cost cargo movement (helos, fuel)

IV. TYPICAL SCENARIOS USING BARGE CLUSTERS

4.1 In this section the barge cluster operational concepts of Section III are structured into typical scenarios for several different size landing forces. Scenarios are developed for MAB- and MAF-size operations, for operations that scale up from MAB- to MAF-size, and for operations that transition from SMLS to conventional types.

4.2 The balance between the quantity of supplies positioned offshore in barge clusters and the quantity stored ashore in the conventional manner represents a range of options from which the commander may choose according to the situation. In conditions where terrain is extremely difficult ashore (such as deep snow, dense jungle or rugged hills and valleys), the ability to hold supplies offshore in barge clusters offers an attractive alternative to extensive shoreside LSA preparation. Similarly, a highly volatile political situation may militate against buildup of supplies ashore, which again makes the offshore cluster an attractive alternative. On the other hand, severe sea conditions, poor beach trafficability, or heavy weather threat may militate against positioning large quantities offshore.

4.3 In the following scenarios, a middle situation is assumed, where shoreside LSA preparation is feasible, and offshore conditions do not disqualify clusters. Using this assumption, it is possible to examine cluster techniques as they might relate to conventional amphibious operations of varying sizes and situations. The paragraphs that follow assess barge clustering in relation to:

a. Support of a MAB

b. Support of a MAF

c. Expansion from MAB-size to MAF-size operation

d. SMLS MAB transition to barge cluster support.

SCENARIO 1—MAB SUPPORT

4.4 The "heavy MAB" identified in Appendix A is used in this scenario. This force consists of about 16,000 troops and requires 17 or 18 amphibious ships plus 16 to 20 MSC or commercial ships for augmentation. Typical numbers and types of amphibious ships for this force are shown in Table A.9. The daily dry cargo needs of the force are about 600 short tons, 1,084 measurement tons (MT) or 1,084 pallet equivalents.

4.5 Assuming that the MAB has set a 30-day stockage objective for supplies, the initial landings are expected to be accompanied with about 10 days of supply with an additional 20 to 25 DOS to arrive in commercial shipping sometime around D+5. In a conventionally supported operation, the commander, already faced on D+5 with the

problem of landing the rest of the landing force (about 30,000 MT and 240,000 sq ft of landing force equipment), would also have to move over 20,000 MT of supplies ashore. He probably expects the first resupply increment to begin to arrive about D+15, which means that he must have the pipeline cleared by that time to make way for still another 20,000 to 30,000 tons. He must, therefore, in addition to all equipment, move supplies ashore at the rate of about 3 days of supply (DOS), or 3,200 tons per day.

4.6 If the supplies and perhaps part of the equipment are delivered by a LASH ship, however, the difficulty is eased considerably. The commander can then focus his resources on landing force equipment and simply anchor the barges offshore until a more convenient time to unload them. Later, when the entire landing force is on the beach, it will be more convenient to divert landing craft from tactical landings to movement of supplies. Alternatively, he may elect not to land the supplies at all, and to hold all or at least part of them in offshore clusters. To the extent that he holds them offshore, he reduces the throughput requirements on beachhead facilities, down to the point that he only need move supplies ashore at the rate of consumption, the buildup being held in floating dumps or "surge tanks" offshore.

4.7 After the beachhead congestion of the critical early days begins to ease, all or part of the clustered supplies may be moved ashore. As long as the amphibious operation is in progress and the amphibious shipping is still present in the objective area with its landing craft and other assets, movement of the cargo ashore is feasible by drawing on the amphibious assets. Table 4.1 shows the number and types of

TABLE 4.1

TYPICAL LIST OF ASSETS REQUIRED TO MOVE
1 DOS IN FLOATING CRANE OPTION*
(heavy MAB)

5	12-ton cranes
9	Pontoon causeways
3	LCUs
2	LCM-8s
2	Warping tugs
14-21	Flatbed trailers

The above provides:

3	Floating cranes on LCUs
2	Floating cranes on pontoon causeways
2	Warping tugs to maneuver barges and causeway mounted cranes
7	Pontoon causeway ferries
2	LCM-8s to shuttle ferries

* All palletized cargo and based on 12 working hours per day.

assets needed to land 1 DOS per day. During subsequent operations ashore, when the amphibious shipping has departed the objective area, unloading resupply increments from merchant ships is a problem without a ready solution. unless an additional suit of gear, such as a LASH package, is present.

4.8 Table 4.1 lists the assets needed to move 1 DOS per day. The figures have some slack, since they are keyed to a 12-hr work day, which might be extended if necessary. The assets listed are all normally present and can be made available when the commander chooses to divert them from tactical lift of troops and equipment. A heavy MAB, as used here, would probably have about 5 LSTs, each of which could deliver 4 causeways—a total of 20 causeways. The well deck ships could have about 9 LCUs, 12 LCM-8s and 37 LCM-6s. Warping tugs are also included in the craft lists, but these displace LCUs on a one-for-one basis. For the configuration considered here, the two warping tugs listed would displace two of the nine LCUs. This is not a desirable tradeoff, but it is one which traditionally faces amphibious planners. Warping tugs are necessary to install, marry and anchor causeways, which are usually necessary for LST hook-up with the beach. Yet the only means to deliver the tugs is in well-deck space, which displaces landing craft. In this case two LCUs, which might be needed for the tactical movement of tanks would be displaced. Obviously, if supplies are to be built up in shoreside dumps, more than 1 DOS per day must be moved ashore. If, for example, the decision is made to build up 20 days of shoreside stocks in 10 days, the list in Table 4.1 must be multiplied by three, allowing for consumption. Buildup of this type, demanding more assets, will also call for substitution of LCMs as tugs and as trailer shuttles in place of warping tugs, LCUs and pontoon causeways.

4.9 The picture is changed considerably if the LASH ship is equipped with the suit of cargo-handling gear described earlier. A typical one-LASH shipload might look like the list in Table 4.2. A LASH could deliver, on D+2 or D+3 for example, a suit of hardware that could immediately pick up 1,000+ MT per day of cargo movement, to augment the amphibious assets already in use. In addition, the ship could deliver about 20 barges (2 LST loads) of landing force equipment (about 7,400 MT), plus either 15 or 19 days of supply, depending on the particular LASH version being employed. Any time after arrival of this shipload, the landing force would become independent of amphibious shipping for craft to move supplies ashore. Further, after landing the 20 barges of equipment, the barges might be employed as lighters to unload additional merchant ships, or used as floating dumps if so desired, without diminishing the 1,000 MT per day throughput capacity.

4.10 Upon completion of the operation or assignment of a new mission, the entire barge cluster package could be recovered. Empty barges could be used to withdraw landing force equipment or supplies from the shore. On arrival of a LASH ship, the cargo-handling suit and cargo barges listed in Table 4.2 could be recovered in 1 or 2 days.

SCENARIO II—MAF SUPPORT

4.11 The MAF identified in Appendix A is used in this scenario. It consists of about 48,500 troops, 215,400 MT of equipment and 170,600 MT of accompanying supplies. The force requires about 50 amphibious ships for the assault echelon and from 12 to 24 merchant ships for the

TABLE 4.2

TYPICAL ONE-LASH LOAD IN SUPPORT OF HEAVY MAB
(16,000 troops)

Ship-to-Shore Cargo-Handling Suit*		
12	pontoon causeways	Occupies about 13 barge equivalent spaces; provides ship-to-shore cargo throughput of about 1,160 pallets per day, which is required for this force.
2	warping tugs	
2	self-propelled causeways	
1	barge load of ground tackle and mooring gear	
4	cranes	
Landing Force Equipment		
20	barge loads	Roughly equivalent to 2 LST loads. When empty, barges become additional lighters or offshore storage points or subsequent resupply movements.
Landing Force Supplies		
56	barge loads	About 19 DCS for this force.

* Provides full landing force–merchant ship capacity for all merchant ship types, except non-self-sustaining container-ships. This configuration is compared for the 18-barge LASH. For the smaller, 77-barge versions, the 19 DCS is reduced to 15 DCS.

assault follow-on echelon, depending on the type of ship employed. This MAF requires on the average about 1,070 MT of ammunition and 2,200 MT of other dry cargo each day. Background and development of these figures are presented in Tables A.1 through Table A.5.

4.12 This MAF might be expected to land initially about 17 days of ammunition and 5 or 6 days of other dry cargo. The assault follow-on echelon would arrive about D+5 with about 42 more days of ammunition and 40 more days of other dry cargo. Assuming a 45-day stockage objective for supplies, the first resupply increment would arrive around D+15 with about 15 days of ammunition and 30 days of other dry cargo. These figures are important since they frame the nature of the ship-to-shore cargo-handling problem in the first 15 days of the operation. As with the MAB described earlier, the MAF, in a conventionally supported operation, must create a beachhead throughput capacity far higher than its initially needs. To clear the ship-to-shore pipeline before the arrival of about 81,000 tons of supplies begins on D+15, the force must land about 170,575 tons of supplies. This is in addition to about 2[illegible],400 tons of landing force equipment in the assault and assault follow-on echelon. In sum, the beachhead cargo-handling system must be able to accommodate about 386,000 tons of cargo in 15 days, a rate of almost 26,000 measurement tons per day, or about eight times the rate at which the force consumes supplies. There appears little that can be done to alleviate the congestion problem in landing force equipment, since, for tactical reasons, this must be landed as early as the situation ashore permits. This is not true in the case of stocks of supplies, however, and the only reason to pile them up ashore is to free the shipping to move on to other jobs. If, in the conventional

operation, there were some way to unload the ships, but delay processing that huge amount of cargo through the beachhead, beachhead congestion in the first 2 or 3 wk would be greatly eased. The bargeship appears to offer such an alternative.

4.13 Because the barges may be held for extended periods, perhaps indefinitely, in offshore moorings, the supply ships are no longer tied to beachhead throughput capacity. Regardless of the situation on the beach, they are able to unload barge loads of supplies at a very high rate (four barges per hour from a LASH ship translates into a rate of more than 35,000 tons per day) without adding further to beachhead congestion. For the force considered here, where conventional support, added to landing force equipment calls for a beachhead complex capable of handling 26,000 MT per day, this requirement could be decreased by about 8,000 tons per day, a reduction of over 30%. The flow of supplies cannot go to zero, and must, on the average, be at least equal to actual landing force consumption.

4.14 Figure 4.1 displays a typical distribution of barges in the near-shore area during the period that a maximum number of barges are being held offshore, and a number of cargo transfer terminals are activated for cargo movement. For clarity, the area in the sketch has been expanded to show one-third of the area, one-third of the barges and one-third of the throughput hardware that would be required for a full MAF. Here, the beach for a regimental landing team (RLT) is taken to be 1,000 yd wide, the surf zone about 200 yd and a gradient of about 2%, which offers 12 ft of water at 200 yd and beyond and is suitable for barges drawing 7 or 8 ft. For illustrative purposes, Figure 4.1 includes

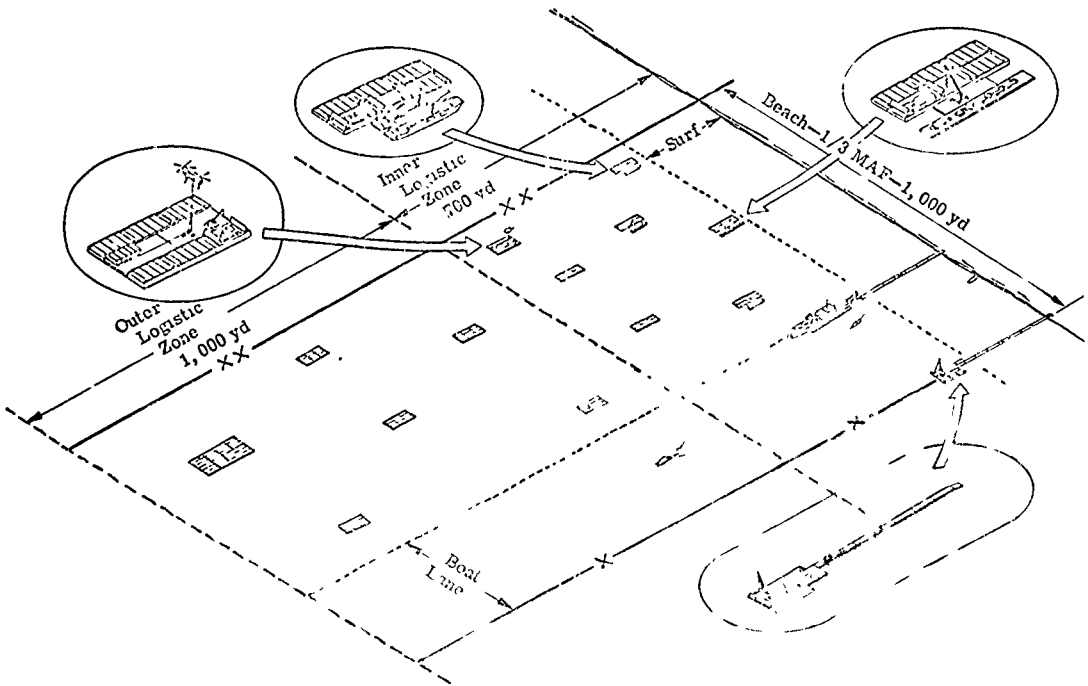


FIGURE 4.1

TYPICAL BARGE DISTRIBUTION FOR 45 DOS FOR ONE-THIRD MAF
(132 barges and ship to shore throughput capacity to support one-third MAF)

an inner logistic zone reaching 500 yd out from the surf zone. Active barges, i.e., barges that are actually involved in unloading operations, are located in this area. The figure shows a helo retail platform, two floating crane terminals, a shorefast causeway and an LST using its own booms to lift cargo out of barges and into vehicles aboard ship. This array of hardware, which is similar to that shown earlier for the heavy MAF, can accommodate in a 12-hr day the daily needs for a third of a MAF. In other words, two similar additional offshore complexes laid out like Figure 4.1 would accommodate the daily pipeline for a MAF.

4.15 The figure also shows an outer logistic zone, which is used here for inactive barges and to avoid congestion in the nearshore area. The outer zone would accommodate larger clusters, and it would be the holding area for empty barges designated for retrograde or for use as lighters in the objective area. A boat lane has been set aside to help avoid boat traffic congestion.

4.16 The number of barges represented here is 133, which is one-third of 399, the number of LASH barges needed to store 45 days of supply for a MAF of the size considered here. Two LASH ships, one equipped with a ship-to shore suit to support one-third MAF could also deliver about 130 barges. If these two ships arrive with the assault follow-on echelon, one-third of the MAF now has its full stockage objective plus a cargo-handling package that can sustain the pipeline without drawdown on landing craft or other tactical assets. In the same way, four LASH ships could do the job for two-thirds of the MAF or six ships for the entire MAF. It is not clear at this point whether it is realistic to consider one-time use of 4 or 6 bargeships out of a

total of 21 in the U.S. flag fleet. There are a number of possible arrangements whereby such availability could be achieved; however, such considerations are outside the scope of this study. Instead, this analysis is limited to the quantitative considerations and logistical impact of introducing this new capability, without regard for the existing or projected U.S. flag fleet or its degree of commitment to national defense.

SCENARIO III—EXPANSION FROM MAB- TO MAF-SIZE OPERATION

4.17 This scenario is essentially a variation on the MAF-size operation discussed previously and the same quantitative factors apply. The transition to the larger operation is simpler than the conventional MAF landing, since the MAB will already have developed the beach to some extent and will have installed a logistical support structure. An examination of this expansion situation, however, exposes a traditional problem and underscores the need for a specialized suit of cargo-handling gear for the barge carrier. After the landing force is established ashore and the assault is underway, it may become desirable to assign the ships of the ATG to other missions. This means taking their landing craft with them which, in turn, means that the landing force has no resources with which to unload cargo ships bringing in the supplies to sustain the operation. One solution is to leave part of the ATG in the objective area with their landing craft. However, this solution diminishes the amphibious capability of the ATG to the extent that ships and craft are pulled out for this cargo-handling mission. Further, this results in inefficient allocation of resources, since the ships to which the boats belong are then not effectively employed.

4.18 An alternative is to use the amphibious ships for resupply, but this also results in inefficient resource management. Being optimized for amphibious landings, an amphibious ship is not a good line-haul cargo ship. For example, the LST and LSD, each with about an 8,000-ton displacement, carry only about 2,000 to 3,000 tons of cargo. A commercial ship of similar size would haul twice that quantity or more. But most important, use of amphibious ships for line-haul cargo operations makes them unavailable for amphibious operations.

4.19 The whole problem is solved, however, if a LASH ship, with its own suit of handling gear is introduced into the operation. The amphibious ships are then free to depart whenever they are needed elsewhere, without penalizing the operation. It should be noted that this problem of unloading resupply increments is not unique to a MAB-to-MAF growth situation, but is a long-standing problem in amphibious operations. Thus, a LASH ship, with its own suit of handling gear not only solves the problem in this specific scenario, but applies equally to all other operations where one would not prefer to keep the entire amphibious task force standing in the objective area during subsequent landing force operations ashore.

SCENARIO IV—SMLS MAB TRANSITION TO BARGE CLUSTER SUPPORT

4.20 The large share of the work done to date in relation to seaborne mobile logistics has been devoted to Marine Amphibious Unit (MAU) size

operations. Presearch Incorporated, however, has made several contributions to the literature in publications relating to logistic sea-basing at the MAB level. 1/ These documents are used as background for this scenario which addresses a MAB-level operation. The MAB was selected for analysis purposes rather than a MAF, which is probably too large a force for total sea-basing, or a MAU, whose relatively small daily requirements do not constitute a major logistic burden.

4.21 The sequence begins with the amphibious operation in progress, with a streamlined MAB ashore, supported from a logistic sea base. The MAB used here is the "light MAB" described in Tables A.8 through A.12 and related text. This MAB assumes that fixed wing air is operating from carriers and rotary wing air is based aboard LPH or LHA ships. Maintenance is being performed in LPDs, and an LKA-113 Class ship is providing the majority of resupply on a helicopter retail basis directly from the ship to the landing force customer.

1/ Amphibious Cargo Handling Aboard Ship in a Selective Unloading Environment (U), Technical Report No. 187, 26 October 1970, UNCLASSIFIED; A Methodology for Conducting Systems Analyses of Cargo Handling in Amphibious Ships in an Advanced Logistic Environment (U), Technical Report No. 219, 15 May 1972, UNCLASSIFIED; Systems Analysis of the LKA-113 Class Ship Operating in an Advanced Logistic Environment (U), Technical Report No. 220, 22 June 1972, UNCLASSIFIED; Amphibious Seabase Replenishment (U), Technical Report No. 228, December 1972, CONFIDENTIAL; Systems Analysis of the LPD-4 Class Ship Operating in an Advanced Logistic Environment, Technical Report No. 245, 20 December 1973; Amphibious Sea-Base Replenishment Using Merchant Ships (U), Technical Report No. 248, publication pending, CONFIDENTIAL.

4.22 The total dry cargo needs for this force are about 445 pallets daily (see Table A.10). Assuming that the entire landing force is ashore and that the logistic sea base is in full operation, replenishment of the sea base itself may be provided from merchant ships using landing craft as lighters. Other amphibious ships may also be used for replenishment, although, as pointed out earlier, this is not a highly efficient allocation of resources. A third replenishment technique, and by far the most attractive, is the use of a barge-carrying ship. The barge carrier need only pause long enough in the objective area to unload the designated barges, then go on its way. The barges can be brought alongside the amphibious ship to be replenished, which can take the cargo aboard at its own best rate. Excess barges may be held alongside or clustered in the vicinity for later use. In fact, in the case of artillery ammunition, packaged POL and rations, helicopters might pick up pallets directly from the barge for delivery to the landing force customer. In this arrangement, system management would be by a designated ship of the ATG.

4.23 Orders are received at this point that pressing requirements elsewhere require that the amphibious shipping be freed and that the logistic sea base be shifted out of the ships. One option would be to move the entire operation ashore and start to build up a shore-based logistic facility to handle the supplies. However, since the operation was originally planned using a logistic sea base, it is assumed that the same factors militating against shoreside logistics still apply. In this case the offshore barge cluster appears to be a preferable option. Shifting to a barge cluster support system frees the ships, yet does not add to the buildup of a shore-based installation.

Obviously, some shoreside buildup will be required. If the ships depart, an aviation complex must be built up ashore, at least for the rotary wing aircraft. The supply function, however, does not have to go ashore, and to the extent that it can continue to operate from offshore facilities, the size of the shore-based structure can be held down and the size of the eventual retrograde problem reduced. Figure 4.2 illustrates the basic request and supply flow from a logistic sea base. Figure 4.3 illustrates the transition. Control of the logistic operation, which would have been located aboard ship in a sea-based operation, would be shifted ashore with the landing force command post. The Ship's Logistic Coordination Center (SLCC), which manages the inventory and requisition system in the ship, might be shifted to a beachhead forward logistic facility, or to a floating facility in a barge cluster. If LASH or Seabee ships were employed for replenishment in the SMLS phase, these ships would continue in the same role. Thus, the shift from a logistic sea base to a barge-cluster-supported operation appears to be an easy one, and it has the advantage of continuing to minimize the shoreside profile.

4.24 Figure 4.4 shows a typical barge cluster layout for a light MAB beach. The barges in the illustration are to approximate scale, and the 36 LASH barges depicted there represent 30 days of supply for this force. The single helicopter retail platform described earlier, with two cranes and two or three forklifts, is easily capable of sustaining the 445-pallet-per-day pipeline. Military prudence might suggest that two small platforms would be better than one large one. In this case, the same resources could be reconfigured into two platforms of four causeways and one or two forklifts each.

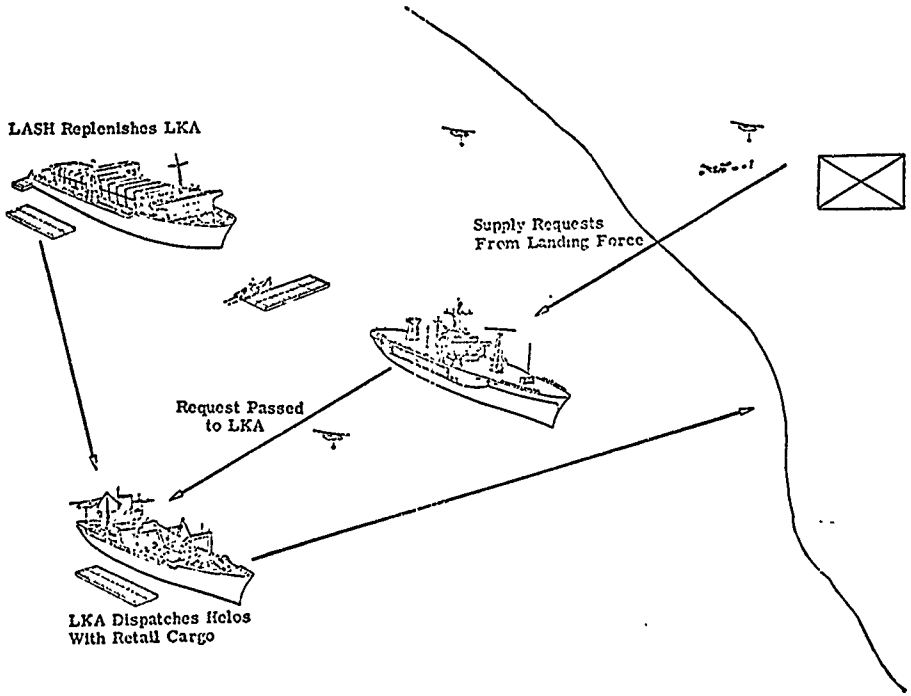


FIGURE 4.2
SMLS SUPPLY FLOW

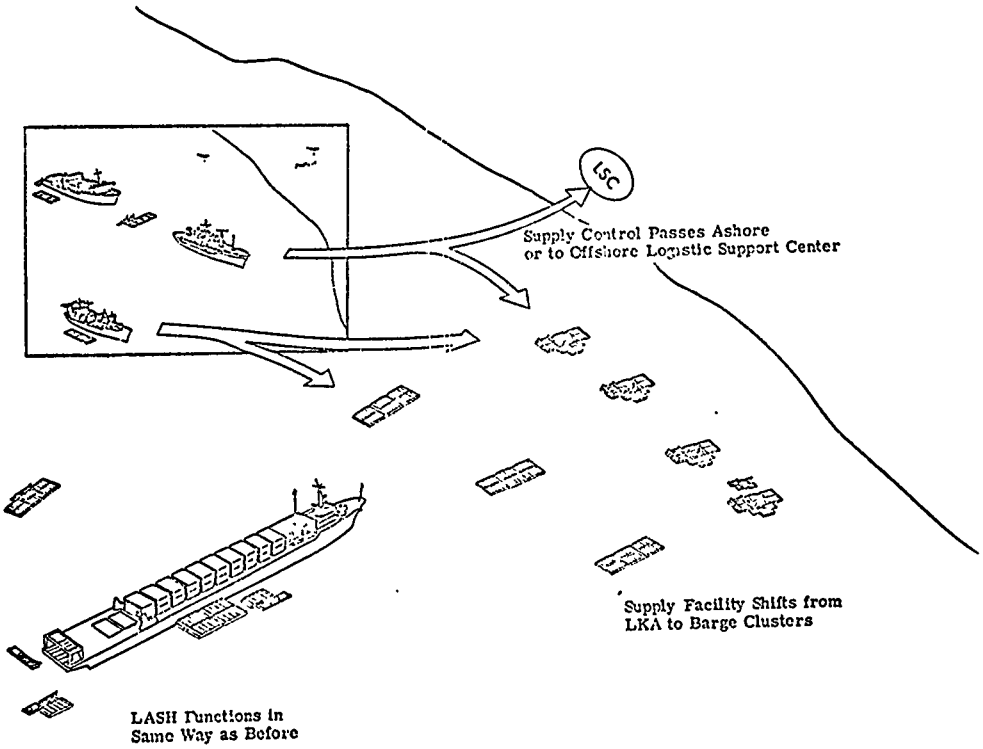


FIGURE 4.3

SMLS SUPPLY FLOW SHIFT TO BARGE CLUSTERS

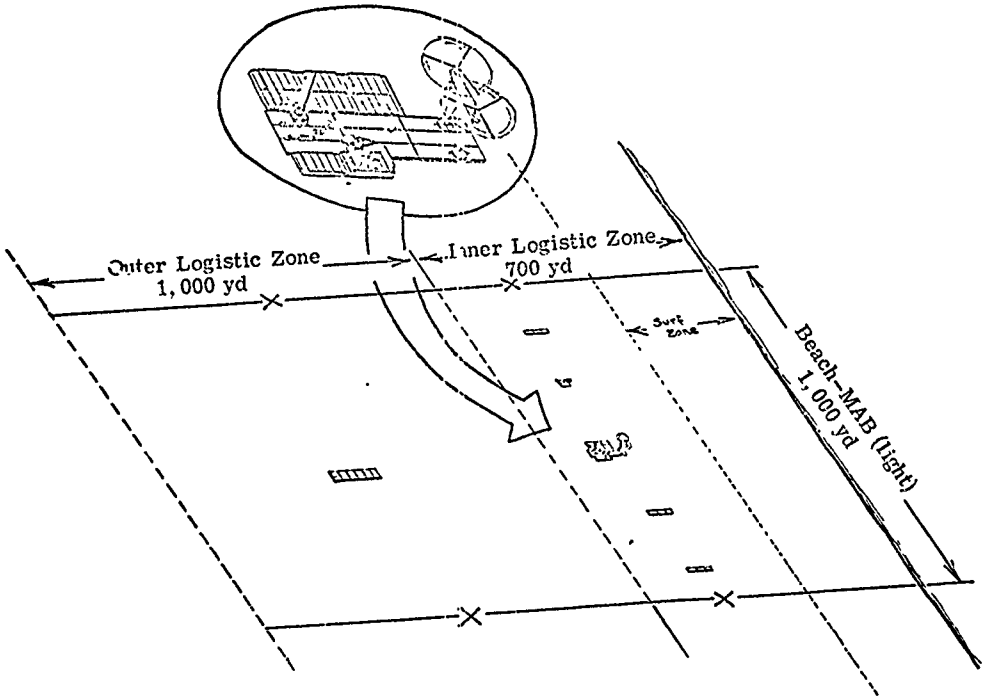


FIGURE 4.4

TYPICAL BARGE CLUSTER LAYOUT FOR LIGHT MAB BEACH

4.25 In sum, there is no technical reason why barges could not be used to great advantage in this way. It should be emphasized that use of the helicopter retail mode must be looked upon as an option that the commander can select if it fits the circumstances. There are many circumstances when it would not be practical to rely solely on helicopters for supply support. On the other hand it should be noted that a number of decisive MAB-size operations in Vietnam were supported solely by helicopter. Thus, helicopter retail support and SMLS transition to nearshore barge clusters should be taken to be a new option that is open to the commander if it fits his particular situation.

5.3 In some applications, barges can result in substantial savings in manpower and dollar cost. On the average, for any given quantity, the purchase cost of barges to store all classes of dry cargo is about 37% less than the estimated dollar cost to construct shoreside LSA facilities for the same quantity. Although not immediately apparent, a very large man-hour effort is required to construct even the most basic shore-based LSA facilities. For example, if one-third of a MAF's normal supply stockage were positioned offshore in barges, the man-hour savings in shoreside construction would be roughly equivalent to the effort to build 20 mi of two-lane dirt road and sweep it for mines each day for 5 days.

5.4 Holding supplies in nearshore barge clusters reduces the number of physical handling steps in the ship to customer pipeline. In almost all physical handling arrangements, at least one load-unload step at the LSA or dump is saved by holding the supplies offshore until they are to be delivered to the customer.

5.5 A nearshore barge cluster system is readily adaptable to a mixed pallet-container pipeline. Most LASH ships have container gantry capability and can therefore be self-sustaining. Additionally, the barges themselves can accommodate up to seven containers each internally. When the barge space not used by containers is filled with pallets, there is little overall loss in stowage space in the barge. Barges can also accommodate up to seven containers topside on the hatch covers. If the beachhead then is equipped with an elevated causeway and container crane such as that discussed in the body of the report, a barge-ship system brings landing force container interface with all U.S. flag cargo carriers except non-self-sustaining containerships.

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CONCLUSIONS RELATED TO OPERATIONAL CONSIDERATIONS

5.6 Barge cluster support should be viewed as an option, rather than as an either-or logistic choice. Nearshore barge cluster storage of supplies can be exercised to as large or as small an extent as the situation requires. Further, in changing situations, cargo can be readily shifted from barge clusters to shoreside storage, if that becomes desirable. This represents a major benefit in tactical flexibility.

5.7 Using existing amphibious assets, a standard, commercially configured barge carrier can greatly ease beachhead congestion in the early days of an operation. Where, in the conventional operation, ship unloading is locked to beachhead capacity to handle the cargo, barge clusters would allow immediate ship unloading, but movement across the beach at a later, more convenient time.

5.8 A cargo-handling hardware suit transportable in the LASH ship can solve the long-standing problem of unloading the assault follow-on echelon and subsequent resupply increments. Under present concepts the assault follow-on echelon and subsequent resupply are delivered by Military Sealift Command (MSC) or commercial shipping. However the only lighters to unload these commercial ships belong to the Amphibious Task Force in the form of landing craft. Unless the ATF is to remain in the objective area until the troops are retracted, other provision must be made for transfer of cargo from merchant ships. A LASH cargo-handling suit brings full ship-to-customer capability, for commercial or Navy ships, while allowing the amphibious ships and their landing craft to depart for other operations.

RECOMMENDATIONS

5.9 A program of hardware development and feasibility and engineering tests should be instituted at an early date to provide a LASH-deliverable suit of hardware that would provide a full pallet-container interface capability between commercial ships and the landing force ashore, independent of specialized ATF assets. Much progress has already been made in this area in the form of jack-up causeway development, propulsion unit development, plus feasibility test, so that articulation of a suit of hardware for LASH might be a relatively modest program, considering the substantial operational benefits to landing force logistics.

5.10 Tests, such as those conducted with LASH barges by NCEL at Coronado, should be continued and accelerated. For reasons cited in this report and elsewhere, there is good reason to think that barge-carrying ships have much promise in amphibious logistic support. Therefore, thorough investigation of these prospects using actual tests appears to be an extremely wise investment of time and effort. Such tests validate or disprove estimates, expose promising new areas and in general offer high-return payoff in those cases where the capabilities of the new ships can be brought to bear. Among the major areas needing test are the mooring, maneuvering and breakwater needs, effort required to establish and maintain a nearshore complex, the sea conditions that limit barge carrier discharge and retrieval, the ma ....um and optimum sizes and shapes of clusters, and actual ability of the ships to accept outsize loads.

APPENDIX A
BASIC BARGE LOGISTIC SYSTEM INPUTS

A.1 This appendix presents representative troop lists, cargo profiles and amphibious resource lists, which are used as basic working inputs to the analysis presented in the body of this report. It also summarizes the characteristics of the LASH and Seabee barge systems that are central to this report. Finally, it describes the interface vehicles that are employed in the military scenarios being considered.

A.2 In examining the employment of bargeships and barges in support of amphibious operations, it is important to keep in mind that the basic system constraints are set by the customer—the landing force ashore. The requirements of the landing force determine the size and nature of the cargo pipeline, which in turn tends to shape the entire logistic system supporting the operation. The principal measure of system effectiveness must invariably be the ability of the system to support the landing force ashore and its ability to enhance, rather than deplete, the landing force assets. Analysis of system feasibility must therefore be made in relation to the landing force. This requires postulation of a specific landing force described by size, daily cargo requirements, numbers and types of ships needed to deliver the landing force and finally, the accompanying logistic support vehicles such as landing craft, tugs and cargo-handling hardware.

COMPOSITION OF FORCES

A.3 The number and types of ships and the troops and equipment in the landing force are all determined on the basis of the specific amphibious mission to be accomplished. A Marine Amphibious Force (MAF), for example, might reasonably be built around four infantry regiments and, because of the mission, include more artillery, tanks and helicopters than a normal four-regiment share. Such a force might easily contain 55,000 or more troops. A light MAF, on the other hand, might be tailored to a different mission and be built around two regiments and contain less than 30,000 troops. Similar variations apply to the Marine Amphibious Brigade (MAB). Amphibious shipping is also assigned on the basis of the mission and is keyed to the number of troops in the landing force, which means that there are also wide variations in the composition of an Amphibious Task Force or Group.

A.4 In light of the foregoing, a set of notional landing forces was adopted for use in this study. These notional forces establish three specific points along the wide span from a light MAB to a heavy MAF, and facilitate quantitative analysis. The three notional forces are a three-regiment MAF, at about 48,000 troops; a relatively heavy one-regiment MAB, equivalent to one-third MAF; and a light MAB, organized for a Seaborne Mobile Logistics System (SMLS) type operation that requires about the same firepower as the larger MAB, but does not provide a logistic plan ashore. Each force is accompanied by appropriate amphibious shipping, based on a realistic share of actual present and programmed ships in the amphibious forces of the Navy. These notional forces are described in more detail in the following

paragraphs along with supply requirements expressed in terms of ship and barge equivalents.

Amphibious Task Force/Marine Amphibious Force

A.5 Tables A.1 and A.2 display a force breakdown of the MAF used in this study, and allocation of amphibious shipping needed for the assault echelon of a force of that size. Table A.3 shows the MSC or commercial shipping required for the cargo and equipment of the assault follow-on echelon. The 14,905 troops were omitted from Table A.3 since the troop movement and accommodation problems are outside the scope of this study.

A.6 Table A.4, using standard consumption factors, describes the daily MAF consumption, by supply class in short tons, in approximate number of pallets, and in number of containers (MILVANs). The numbers in the three columns are not additive; that is, 159 short tons of Class I per day represent about 477 pallets, or 24.5 containers.

A.7 Table A.5 shows the numbers of LASH or Seabee barges required for 1 day of supply and a 45-day supply inventory. The number of containers shown is based on the maximum number of containers that can be carried in the barges under the square of the hatch; 7 in the case of the LASH barge and 11 in the case of the Seabee. Using this technique, pallets can also be loaded under the overhang, creating mixed pallet-container loads. The broken stowage factors of these mixed loads are essentially the same as for an all-pallet load, so that the number of barges shown below as required

TABLE A.1

TYPICAL MARINE AMPHIBIOUS FORCE
(all figures in thousands)

Echelon	Unit Equipment				Supplies								
					Accompanying Supply			Ammunition			Subtotal		
	Troops	Short Tons	Meas. Tons	Square Feet	Short Tons	Meas. Tons	Cubic Feet	Short Tons	Meas. Tons	Cubic Feet	Short Tons	Meas. Tons	Cubic Feet
Assault 1/	33.4	29.9	119.8	689.0	4.0	12.0	480.2	18.2	18.2	731.0	22.2	30.2	1,211.2
Follow-on 2/	14.9	31.4	95.6	722.1	29.3	87.9	3,516.3	52.4	52.4	2,099.0	81.7	140.3	5,615.3
Total	48.3	61.3	215.4	1,411.1	33.3	99.9	3,996.5	70.7	70.7	2,830.0	104.0	170.6	6,826.5

1/ Assault echelon carries 5.5 days of dry cargo, less ammunition, and 17 days of ammunition.

2/ Follow-on echelon includes 40.3 days of dry cargo, less ammunition, and 49 days of ammunition.

TABLE A.2
AMPHIBIOUS SHIPPING FOR TYPICAL MAF

Ship		Troops	Vehicles, sq ft	Cargo, cu ft	Bulk POL	Helo 46-Equiv.	LCU	LCM-8	LCM-6
Type	Number								
LPH	6	11,184 1/	26,700	258,000	2,853,000	168	0	0	0
LPD	11	9,731	145,420	429,440	4,097,500	22	11	0	33
LSD	10	3,380	117,800	11,600	320,000	—	10	20	30
LST	16	7,346 1/	253,440	66,400	6,128,000	—	—	—	—
LKA	5	1,226	188,200	345,650	495,000	—	—	20	25
LCC	2	600	—	—	—	—	—	—	—
Total	50	33,467	731,560 2/	1,111,090	13,893,500	190	21	40	85

1/ Some minor overloading of troops is required in these ships.
2/ Excess vehicle square is converted to cargo cube at heights of 7 ft.

TABLE A.3

MSC OR COMMERCIAL SHIPPING REQUIRED TO DELIVERY ASSAULT FOLLOW-ON ECHELON

Ship Type	Number in U.S. Fleet 1/	Individual Ship Cap. (ft^3 x 1,000) 2/	Number of Ships Required			Remarks
			Equipment	Supplies	Total	
C-3	52	430.5	11.0	13.0	24	Most of these ships have at least one large boom, which serves two holds. Its capacity is 50-80 tons. Remaining holds are served by booms of 5-15 tons.
C-4	85	469.5	10.1	12.0	22.1	
C-5	18	741.3	6.4	7.6	14	
LASH	11	1,137.0	6.6 3/	4.9	11.5	
Seabee	3	1,330.5	7.5 3/	4.2	11.7	At present, 9 additional LASH ships are under construction or on order
LST	11	2.7	56.5	41.8	98.3	
CSS 5/	21	482.8 5/	— 7/	11.6	—	
CNSS 6/	85	713.7 6/	— 7/	7.9	—	No capability to off-load containers in AOA

1/ Military Sealift Command, Merchant Ship Register, Washington, D.C., October 1973.

2/ 75% broken stowage applied.

3/ The cube to square ratio of the LASH ship is less than that of the Seabee.

4/ TERREBONNE PARISH Class.

5/ Containership, self-sustaining; capacity is average of the 21 self-sustaining containerships in U.S. flag fleet.

6/ Containership, non-self-sustaining; capacity is average of the 85 non-self-sustaining containerships in U.S. flag fleet.

7/ Estimates of container/equipment compatibility are subject of extensive other studies and are outside the scope of this analysis.

TABLE A.4

DAILY MAF CONSUMPTION

	Major Classification	Short Tons per Day	Pallets 1/	MILVANs 1/
I.	Subsistence	159	477	24.5
II.	Clothing, indiv. equipment, tentage, original tool kit/ sets, admin. and housekeeping supplies and equipment	71	213	10.9
III.	POL: petroleum, fuels, lubricants	3,392	—	—
IV.	Construction; fortification/ barrier material	201	603	30.9
V.	Ammunition	1,071	1,071	54.9
VI.	Personal demand items	121	363	18.6
VII.	Major end items	78	234	12.0
VIII.	Medical material	7	21	1.1
IX.	Repair parts (less medical)	83	249	12.8
X.	Material to support non-military programs	7	21	1.1
	Total	1,798 2/	3,252	166.8 3/

Source: CMC letter to CNO Ser 13095, 7 April 1970.

1/ The estimated numbers of pallets and MILVANs for 1 DOS are based on the common logistical planning assumption that 1 short ton is equal to 3 measurement tons of all supply classes, except Classes III and V, and 1 short ton is equal to 1 measurement ton of Class V. This assumption yields reliable figures for average densities of containers when dealing with large quantities, but it should not be used to estimate frequency distribution of individual container densities. For example, 10 or 11 MILVANs, on the average, would be required to transport the total 70-odd tons of Class II required by a MAF daily, although any individual MILVAN may transport considerably more or less than 7 tons.

2/ This figure represents the total daily consumption of packaged dry cargo. It does not include the daily 3,392 short tons of POL, which is largely handled in bulk.

3/ This figure represents the number of MILVANs that would be required to package all the daily dry cargo needs of a MAF. It is not intended to indicate a MAF's actual container-handling requirement, since a share of the cargo may instead be palletized or carried as breakbulk, depending on the situation at the time of the operation. In this table, MILVANs are assumed to be loaded in a breakbulk manner, with 75% utilization of bale cube because of broken stowage.

TABLE A.5

REQUIRED NUMBER OF BARGES FOR 1 DOS AND A 45-DAY INVENTORY FOR MAF-SIZE FORCE

a. Barges Loaded With Pallets

Supplies	LASH Barges	Seabee Barges
1 day	8.86	4.36
45-day inventory	399	195

b. Barges Loaded With Maximum Number of MILVANs and Remainder of Available Space Loaded With Pallets

Supplies	LASH			Seabee		
	Barges	Pallets	MILVANs	Barges	Pallets	MILVANs
1 day	10.2	1,591	72	6.9	1,180	97
45-day inventory	459	71,604	3,240	310	53,100	4,365

Note: One LASH barge = 7 MILVANs + 156 pallets = 317 measurement tons.

One Seabee barge = 14 MILVANs + 171 pallets = 472 measurement tons.

for 1 day of supply is the same whether the load is made up of mixed containers and pallets or of pallets only.

A.8 Conventional concepts envision a minimum dry cargo stockage objective of about 45 days of supply to be held in the amphibious objective area. Early in the operation the daily landing force needs will be met from cargo delivered in the assault and assault follow-on echelons. Since the combined quantity of cargo included with those two echelons consists of only about 45 DOS of dry cargo, additional incremental resupply shipments are programmed to arrive in time to restore landing force stocks to at least 45 DOS and subsequently sustain them at a rate equal to 1 DOS per day. These operations are summarized in the dry cargo resupply schedule given in Table A.6. The right side of the table shows the approximate number and types of ships required to lift the supply increments described earlier. Not immediately apparent in this chart is the great difference in time and work load needed to off-load the different ship types in the objective area. For example, to deliver the equipment and cargo of the assault follow-on echelon, 24 C-3 type ships would be required. This would call for dockside unloading space and cargo-handling gear for the 24 ships, or else lighters to move 105,000 short tons of cargo. Eleven LASH or Seabees on the other hand could discharge lighters simultaneously, requiring only ground tackle, moorings and tugs to shuttle barges a short distance. The body of the report deals at length with a suit of gear that would also allow the bargeship to transport the tugs and ancillary equipment.

TABLE A.6

TYPICAL LANDING FORCE DRY CARGO RESUPPLY SCHEDULE

Echelon	Time	Days of Supply				Number of Ships Required for Resupply				
		Arrivals		On Hand						
		Dry*	Ammo	Dry*	Ammo	C-3	C-4	C-5	LASH	Seabee
Assault	L-day	5.5	17	5.5	17	—	—	—	—	—
	L+4	—	—	1.5	13	—	—	—	—	—
Assault Follow-on	L+5	40.3	49	41.8	62	24	22.1	14	11.5	11.7
	L+14	—	—	32.8	53	—	—	—	—	—
1st Resupply	L+15	30	15	62.8	68	7.5	6.9	4.4	2.9	2.5
	L+29	—	—	48.8	54	—	—	—	—	—
2nd Resupply	L+30	15	15	62.8	68	4.5	4.2	2.6	1.7	1.5

*Less ammunition.

Amphibious Task Group/Marine Amphibious Brigade

A.9 Two forces were chosen to demonstrate resupply requirements for a MAB. One is one-third of a MAF (16,000 troops) and all resupply requirements for this force are calculated as one-third of the resupply requirements for a full MAF. This MAB will be referred to as a "heavy MAB." The other MAB used for analysis is a "light MAB" consisting of approximately 9,000 troops. Tables A.7 and A.8 depict the amphibious lift requirements for a heavy and a light MAB. Amphibious shipping requirements for the two forces are given in Table A.9. Standard consumption factors were used to arrive at daily usage rates for these forces. Table A.10 depicts the daily consumption by supply class in short tons, pallets and MILVANs.

A.10 The numbers of LASH and Seabee barges required by a MAB for a 1-day and a 30-day supply inventory are given in Table A.11. The number of containers shown is based on the maximum that can be carried inside the barges. Pallets are loaded under the overhang creating mixed pallet-container loads.

A.11 Landing force requirements are met initially by stocks carried in the ATG/MAB. Table A.12 shows a dry cargo supply schedule for the two forces. Supply arrivals and on-hand stocks are documented in this table, along with numbers of various types of merchant ships required to lift the resupply shipments.

A.12 Before commencing assessment of the feasibility of the use of barges in support of amphibious operations, it is first useful to

TABLE A.7

HEAVY MARINE AMPHIBIOUS BRIGADE LIFT REQUIREMENTS
(all figures in thousands)

Lift Requirements	Vehicles and Equipment				Supplies								
					Accompanying Supplies			Ammunition			Total Supplies		
	Troops	Short Tons	Meas. Tons	Cubic Feet	Short Tons	Meas. Tons	Cubic Feet	Short Tons	Meas. Tons	Cubic Feet	Short Tons	Meas. Tons	Cubic Feet
Amphibious ships*	11.1	9.9	39.9	229.6	1.62	4.87	194.8	6.0	6.0	243.6	7.62	10.87	438.4
Merchant ships**	4.9	10.4	31.8	240.7	3.2	9.6	387.1	1.2	1.2	49.2	4.4	10.8	436.3

* Amphibious shipping carries with it 6.7 days of dry cargo, less ammunition, and 17 days of ammunition.

** Merchant ship augmentation includes 23.3 days of dry cargo, less ammunition, and 13 days of ammunition.

TABLE A.8

LIGHT MARINE AMPHIBIOUS BRIGADE LIFT REQUIREMENTS
(all figures in thousands)

Lift Requirements	Vehicles				Unit Equipment			Supplies*						Total		
								Accompanying Supply			Ammunition					
	Troops	ST	MT	Sq Ft	ST	MT	Cu Ft	ST	MT	Cu Ft	ST	MT	Cu Ft	ST	MT	Cu Ft
Amphibious ships	9.1	7.97	31.92	183.5	2.4	9.6	335.1**	3.2	7.3	293.2	2.6	2.2	89.9**	8.2	19.1	768.2**

*23.8 days of supply in force.

**81,753 cu ft of this number is mobile-loadable.

TABLE A.9

AMPHIBIOUS SHIPPING FOR MAB

Ship Type	Ship No.	Troops	Vehicles, Sq Ft	Cargo, Cu Ft	Bulk POL	Helos CH-46 Equiv.	Landing Craft LCU	Landing Craft LCM-8	Landing Craft LCM-6
Heavy MAB									
LPH	2	3,600	8,900	86,000	951,000	56	—	—	—
LPD	4	3,440	52,880	156,160	1,490,000	8	4	—	12
LSD	4	1,320	40,360	4,640	128,000	—	5	8	11
LST	5	2,170	79,200	20,750	1,915,000	—	—	—	—
LKA	2	548	56,740	109,420	165,000	—	—	4	14
LCC	1	300	—	—	—	—	—	—	—
Total	18	11,370	238,080	376,970	4,649,000	64	9	12	37
Light MAB									
LPH	2	3,600	8,900	86,000	951,000	56	—	—	—
LPD	4	3,440	52,880	156,160	1,490,000	8	4	—	12
LSD	3	990	30,270	3,480	96,000	—	4	6	11
LST	5	2,170	79,200	20,750	1,915,000	—	—	—	—
LKA	2	548	56,740	109,420	165,000	—	—	4	14
LCC	1	300	—	—	—	—	—	—	—
Total	17	11,048	227,990*	375,810	4,557,000	64	8	10	37

* Excess square converted to cube at 7-ft height.

TABLE A.10

DAILY MAB CONSUMPTION

Major Classification	Heavy MAB			Light MAB		
	Short Tons per Day	Pallets	MILVANs	Short Tons per Day	Pallets	MILVANs
I. Subsistence	53	159	8.1	36	57	2.9
II. Clothing, individual equip., tentage, org. tool kit/sets, admin. and housekeeping supplies and equipment	23.6	71	3.6	16	40	2.0
III. POL: petroleum, fuels, lubricants	1,130.6	-	-	172	-	-
IV. Construction: fortification/barrier material	67	201	10.3	42	62	3.2
V. Ammunition	357	357	18.3	122	104	5.3
VI. Personal demand items	40.3	121	6.2	25	79	4.0
VII. Major end items	26	78	4	15	[illegible]	2.9
VIII. Medical material	2.3	7	0.4	2	3	0.2
IX. Repair parts (less medical)	27.6	83	4.3	10	40	2.0
X. Material to support non-military programs	2.3	7	0.4	1	4	0.2
Total	599.1*	1,084	55.6**	269*	445	22.7**

* This figure represents the total daily consumption of packaged cargo. It does not include POL, which is largely handled in bulk.

** This figure represents the number of MILVANs that would be required to package all the daily dry cargo needs of a MAF. It is not intended to indicate a MAF's actual container-handling requirement, since a share of the cargo may instead be palletized or carried as breakbulk, depending on the situation at the time of the operation. In this table MILVANs are assumed to be loaded in a breakbulk manner, with 75% utilization of bale cube because of broken stowage.

TABLE A.11

REQUIRED NUMBER OF BARGES FOR 1 DOS AND A 30-DAY INVENTORY FOR HEAVY AND LIGHT MAB

a. Barges Loaded With Pallets

Supplies	LASH Barges	Seabee Barges
Heavy MAB		
1 day of supply	2.95	1.45
30-day inventory	89	43
Light MAB		
1 day of supply	1.21	0.59
30-day inventory	36	18

b. Barges Loaded With Maximum Number of MILVANs and Remainder of Available Space Loaded With Pallets

Supplies	LASH			Seabee		
	Barges	Pallets	MILVANs	Barges	Pallets	MILVANs
Heavy MAB						
1 day of supply	3.41	532	24	2.30	393	32
30-day inventory	103	15,960	720	69	11,790	960
Light MAB						
1 day of supply	1.40	218	10	0.94	161	13
30-day inventory	42	6,540	300	28	4,830	390

Note: One LASH barge = 7 MILVANs + 156 pallets = 317 measurement tons.
One Seabee barge = 14 MILVANs + 171 pallets = 472 measurement tons.

TABLE A.12

TYPICAL LANDING FORCE DRY CARGO RESUPPLY SCHEDULE

Arrivals	Time	Days of Supply				No. of Ships Required for Resupply				
		Arrival		On Hand						
		Dry*	Ammo	Dry*	Ammo	C-3	C-4	C-5	LASH	Seabee
Heavy MAB										
Amphibious ships	L-Day	6.7	17	6.7	17	—	—	—	—	—
Merchant ships	L+5	23.3	13	30	30	2.0	1.8	1.2	.759	.64
	L+14	—	—	16	16	—	—	—	—	—
1st resupply	L+15	30	30	45	45	3.0	2.8	1.75	1.14	0.97
	L+29	—	—	31	31	—	—	—	—	—
2nd resupply	L+30	15	15	45	45	1.5	1.4	0.875	0.57	0.485
Light MAB	L-Day	23.8	23.8	23.8	23.8	—	—	—	—	—
	L+5	—	—	16.8	16.8	—	—	—	—	—
1st resupply	L+8	30	30	45.8	45.8	1.24	1.13	0.72	0.469	0.40
	L+37	—	—	16.8	16.8	—	—	—	—	—
2nd resupply	L+38	30	30	45.8	45.8	1.24	1.13	0.72	0.469	0.40

*Less ammunition.

summarize the characteristics of the ships and barges to be used in the analysis.

A.13 A simplified plan and profile view of the LASH ship are shown in Figure A.1. Table A.13 shows the principal characteristics of the two basic LASH configurations and of the steel and fiberglass barges. The draft at cargo load curve for both barges is shown at Figure A.2.

A.14 Currently there are nine LASH ships in operation by the U.S. merchant fleet. Two additional ships are awaiting delivery. A longer LASH has been designed that has a 15% greater volume capacity and a 36% greater weight capacity than the current configuration. Nine of these ships are due for delivery between 1973 and 1975. Four LASH ships are in operation by European and Japanese lines, bringing the total worldwide LASH population, existing and programmed, to 24. There are approximately 2.4 suits of barges per LASH ship. 1/

SEABEE SYSTEM

A.15 The profile and upper barge deck of the Seabee ship are shown in Figure A.3. Table A.14 shows the principal characteristics of the Seabee barge and ship system. The draft at cargo load curve is shown in Figure A.4. Currently there are three Seabee ships being operated by the U.S. merchant fleet. There are no additional deliveries currently pending or planned.

1/ Maritime Administration, Design Characteristics, August 1972; Military Sealift Command, Department of the Navy, Merchant Ship Register, Washington, D.C., October 1973.

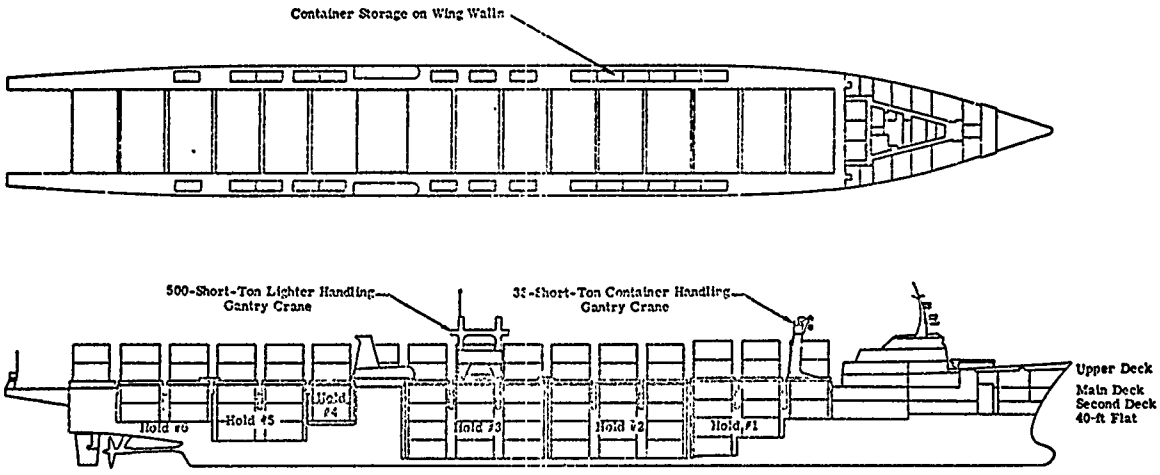


FIGURE A.1

PLAN AND PROFILE OF LASH SHIP SHOWING POSITION OF 77 BARGES IN HOLDS AND ON DECK AND CONTAINERS ON WING WALLS

TABLE A.13

LASH PRINCIPAL CHARACTERISTICS

DESIGN NUMBER	C8-S-81b 1/	C9-S-81d 2/
Length overall (including 48-ft extension), A	820'	893.3
Length between perpendiculars, A	724'	797.3
Beam	100	100'
Draft, design	28'	28'
Shaft horsepower	32,000	32,000
Speed, knots @ 28-ft draft	22.5	22
Crew size	46	33
Displacement (short tons)		
Light ship	16,560	17,998
Noncargo dead weight	7,952	9,184
Displacement @ 28-ft draft	36,568	45,228
Capacity of cargo and lighters	12,056	18,046
Max. displacement @ 35-ft draft	49,959	61,790
Max. capacity of cargo and lighters	25,447	34,608
Max. number of barges	77	89
Container Capacity		
Hold	100	
Deck	164	
LASH BARGE CHARACTERISTICS		
Outside dimensions	61'-6" x 31'-2" x 13'	
Inside dimensions	59'-10" x 29'-6" x 11'-8" (under hatch)	
Bale volume	490 measurement tons	
Barge weight		
Fiberglass	55 short tons	
Steel	95 short tons	
Cargo weight capacity 3/		
Fiberglass	445 short tons	
Steel	405 short tons	
Broken storage volume, (with 75% usage factor)	367 measurement tons	

1/ U.S. Maritime Administration, Pacific Far East Lines Single Screw Cargo Vessel, Plan No. C8-S-81b-S9-0-1, February 1968, UNCLASSIFIED.

2/ U.S. Maritime Administration, Design Characteristics, August 1972; Military Sealift Command, Department of the Navy, Merchant Ship Register, Washington, D.C., October 1973.

3/ Limited by 500-short-ton lift capacity of LASH ship gantry crane.

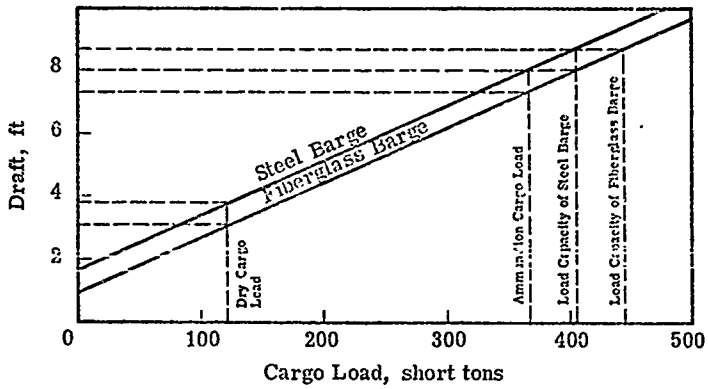


FIGURE A.2

DRAFT AS FUNCTION OF CARGO LOAD FOR LASH BARGE

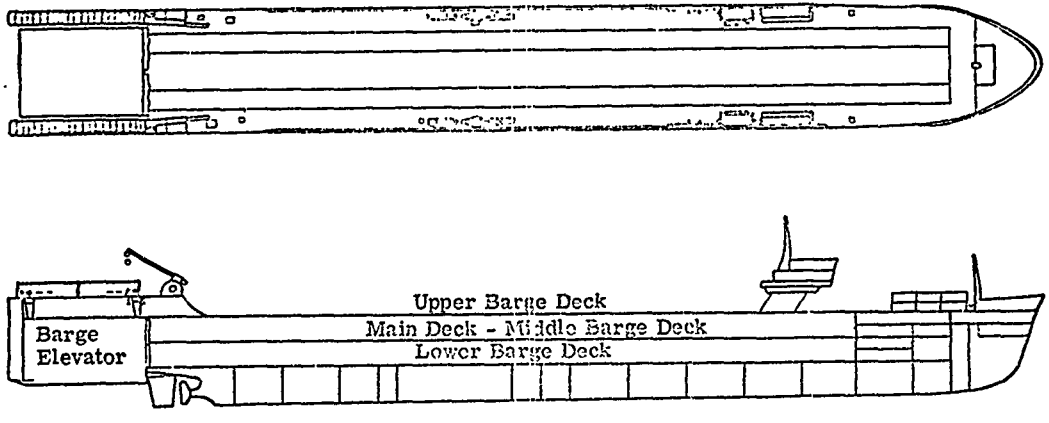


FIGURE A.3
PROFILE OF SEABEE BARGESHIP

TABLE A.14

SEABEE PRINCIPAL CHARACTERISTICS*

SHIP CHARACTERISTICS

Length overall	873' 9"
Length between perpendiculars	719' 11"
Beam	105' 10"
Draft, design	32' 10"
Shaft horsepower	36,000
Speed, knots @ 32' 10" draft	20.1
Crew size	38

Displacement (short tons)

Light ship	19,656
Deadweight @ 32' 10" draft	30,408
Total displacement @ 32' 10" draft	50,064

Barge Capacity

Lower deck	12
Middle deck	12
Upper deck	14

SEABEE BARGE CHARACTERISTICS

Outside dimensions	97' 6" x 35' x 17' 1"
Bale volume	1,000 measurement tons
Broken storage volume, with 75% usage factor	750 measurement tons
Barge weight	166 short tons

*J. J. Henry Co., Inc., Technical Profile of "Lykes Seabee" Barge and Inter-Modal Carrier, October 1968, UNCLASSIFIED.

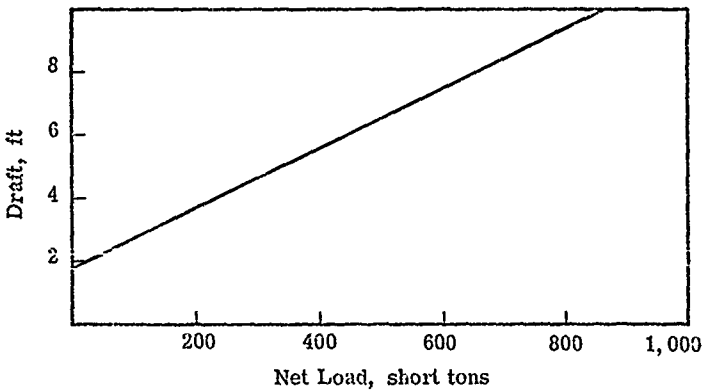


FIGURE A.4

DRAFT AS FUNCTION OF CARGO LOAD FOR SEABEE BARGE

CAPABILITIES OF INTERFACE VEHICLES

A.16 To develop estimates of interface vehicles required by the landing force, it is first necessary to identify the inherent capabilities of these vehicles. The following paragraphs address the individual vehicle weight and volumetric capacities.

Landing Craft, Warping Tugs and Pontoon Causeways

A.17 Interface vehicles such as landing craft, warping tugs and pontoon causeways may be used to transport cargo from offshore barge storage areas to the beach. The principal characteristics of these various transport modes are shown in Table A.15. The actual number of these vehicles carried on any given operation is a function of the prescribed mission and the lift capability of the amphibious shipping allocated. Commonly, 3 or 4 warping tugs would accompany a MAB, but this is at the cost of displacing landing craft in the well deck ships. Four pontoon causeways can be side-loaded on an LST; the total number available on an operation is governed by the number of LSTs assigned. With the advent at a future date of a side-loadable warping tug, the number of causeways deliverable will be reduced by the number of tugs carried; however, the side-loadable tug will reduce the drawdown on well deck space as is now the case. Additional causeways can be delivered in the well decks of amphibious ships but, as with warping tugs, this is not a desirable situation, since it results in displacement of landing craft available for the operation. On the other hand, as discussed at length elsewhere in this report, LASH ships could deliver causeways, tugs, landing craft, ground tackle and lighters, without

TABLE A.15

PRINCIPAL CHARACTERISTICS OF LANDING CRAFT, WARPING TUGS AND PONTOON CAUSEWAYS

Characteristics	LCU-1610	LCM-8	LCM-6	Pontoon Causeway	Warping Tugs
Length overall, ft	135	74	56	90	92
Beam, ft	29	21	14	22	22
Draft loaded, ft	6	5	4	3	6
Payload, lb	376,320	120,000	68,000	250,000 1/	100,000 2/
Cargo well, ft					
Length	124	45	37	—	—
Width	16	15	11	—	—
Depth	4	4	6	—	—
Speed, kt	11	9	9	3 to 4 3/	6

1/ This payload gives about 2-ft freeboard.

2/ Available for anchors and mooring gear.

3/ Based on four-section causeway with one warping tug.

penalizing any amphibious ship space, if such a suit were assembled and made available for future amphibious operations.

Trucks, Trailers and Cranes

A.18 The principal characteristics of trucks and trailers available to the task force are given in Table A.16. These weight and volume capabilities serve as inputs in determining the number of vehicle loads per day required to resupply a given force.

TABLE A.16

PRINCIPAL CHARACTERISTICS OF TRUCKS AND TRAILERS

Vehicle Type	Description	Length, in.	Width, in.	Height, in.	Square, sq ft	Cube, cu ft
M172A1	Semitrailer, low-bed, 60 ton	414	115	68	330	1,873
M118A1	Semitrailer, stake, 6 ton	276	95	104	182	1,578
M127A2C	Semitrailer, stake, 12 ton	345	97	104	—	—
M313	Semitrailer, van, expandable	324	96	132	216	2,376
M105A2	Trailer, cargo, 1.5 ton	166	83	98	96	786
M416	Trailer, amphib cargo, 1/4 ton	109	61	42	46	157
M101A1	Trailer, cargo, 3/4 ton	147	74	83	75	522
M109A3	Truck, van, 2-1/2 ton, 6' x 6'	263	99	130	180	1,958
M35A2C	Truck, cargo, 2-1/2 ton, 6' x 6'	262	96	115	180	1,958
M54A2C	Truck, cargo, 5 ton, 6' x 6'	313	98	118	213	2,094
M37B1	Truck, cargo, 3/4 ton, 4' x 4'	190	74	64	97	520
M151A1	Truck, utility, 1/2 ton, 4' x 4'	132	63	71	59	354
M116A1	Carrier, cargo, amphib	188	82	79	—	—
—	USMC Log. trailer	310	96	36-52	206	620
—	Army MILVAN chassis	241	93	54	155	697

APPENDIX B
PROMISING BARGE-HANDLING TECHNIQUES

B.1 This appendix presents a number of options for discharging retrieving, towing, marshaling, and mooring barges. Some of the data are based on actual tests conducted by the Naval Civil Engineering Laboratory and Amphibious Construction Battalion ONE in Coronado in 1973. Other techniques described have been developed, after analysis of existing test data, by individuals who have considerable practical experience in closely related operations. The individual techniques are not offered as a final word on the subject, or with the implication that they are all highly productive and efficient. Rather, they are used to show that there are a variety of reasonable and practical ways to solve the problems of handling barges in nearshore waters, and that these operations should present no problems for knowledgeable fleet personnel.

LAUNCH AND RETRIEVAL OF BARGES

B.2 Actual techniques for launching the barge and subsequently lifting it aboard are set by the ship's hardware—the LASH gantry and the Seabee elevator. However, the techniques for handling the barges immediately upon launching and preparations for their retrieval are subject to wide variations. The following paragraphs discuss several techniques that are feasible within the normal resources of a conventional

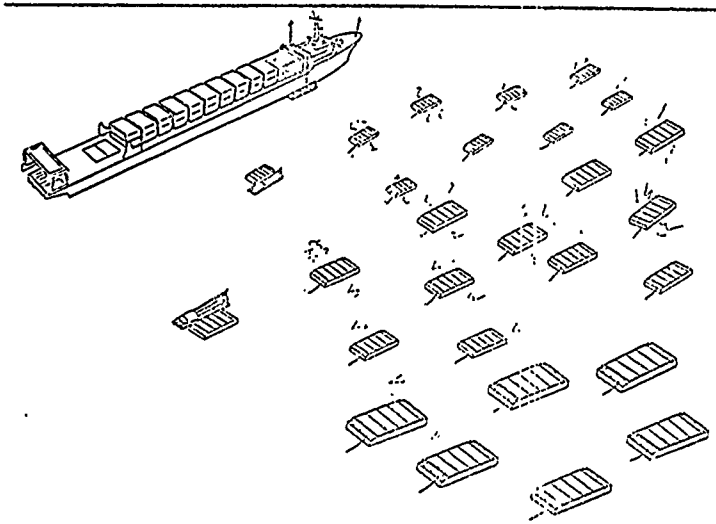
amphibious operation, without a special cargo-handling package in the barge carrier. The special package does not alter this situation, since warping tug performance would be the same in either case.

Barge Launch

B.3 Once the barges are in the water, the next launch problem is to clear barges from the stern of the ship to allow other barges to be launched and to secure the launched barges in such a way as to minimize the drawdown on amphibious assets such as landing craft and warping tugs. Beyond the problem of barge launch itself, the self-sustaining containership capability of LASH can also introduce the problem of container handling at the same time. Depending upon the particular technique employed, several tug and barge handling options are available; these are discussed below.

B.4 Individual Barge Handling. Tugs pick up barges as they are initially launched, move them a short distance and anchor them individually, and then return for another barge. This technique allows good utilization of tugs since two teams of tugs shuttling barges to an anchorage near at hand could probably support a LASH ship, e.g., launching barges at the rate of four per hour. This technique is illustrated in Figure B.1.

B.5 To handle barges individually, the tugs carry ground tackle, and secure the cables to barges as they are enroute to the anchorage. Upon arrival at the desired anchorage, the tug releases the anchor and returns to the ship. The warping tug is best suited to this operation since it can position about 12 anchors and cables on the bow. However, the LCU and



LASH arrives in AOA with anchors and other ground tackle for each barge. Alternatively, this will have been delivered in amphibious ships.

LASH container gantry loads anchors onto warping tugs.

Warping tugs pick up barges as they are discharged, tow them to nearby anchorage, anchor them and return for another barge. Warping tug can carry 12 to 15 anchors and other ground tackle needed for individual barge anchoring.

After LASH has discharged its barges and departed, individual barges may be assembled into clusters or left individually anchored. Large numbers of individually anchored barges may have substantial attenuation effect on sea condition in beachhead area.

Referring to Figure B.8, single loaded barges, anchoring in firm sand, 4-kt current and 70-kt wind, require an anchor equivalent to a 200-lb NavShips lightweight anchor. Though the required length of cable is highly variable, in a case where barges are anchored 500 yd offshore in a 2% beach gradient, with a bottom which gives holding with 5 to 1 scope, each anchor would require 150 ft of cable. Interestingly, under the same conditions, the empty barge requires a substantially heavier anchor than the loaded barge. In that case the empty barge would require roughly the equivalent of a 500-lb lightweight anchor, and prudence would probably call for increasing the scope to 7 to 1, making each cable 210 ft long rather than 150 for the lighter job.

FIGURE B.1

LASH DISCHARGE USING INDIVIDUAL BARGE TECHNIQUE

LCM can carry anchors and cables in a position where they can be easily released. Although this remains to be explored in more detail, it appears that the LCM or LCU might handle 4 or 6 anchors per trip, respectively. The anchors would be suspended outboard so that they could be released without an A-frame or windlass.

B.6 Clusters Formed Alongside Barge Carrier. An alternative technique for handling barges as they are launched is to form the clusters alongside the ship that delivered them (see Figure B.2). Using the ship's winches to haul the barges forward or aft and to hold them, the tugs warp the barges from the stern around to the side of the ship. Although an individual barge-handling technique appears more attractive for temporary barge holding, the formation of clusters alongside may be a more convenient arrangement by which the clusters are moved from the ship directly to semipermanent moorings, or to anchorages in an outer logistic zone. The principal merit of the technique is utilization of the ship's winches, which would otherwise be idle during the unloading period, possibly increasing the flexibility in the use of tugs and moorings. The size of the clusters is limited by the abilities of the particular tugs being employed. The tugs are discussed in detail later.

B.7 Clusters formed alongside may be assembled in strings of 2 to 5. Upon arrival at a mooring point, the first barge in the string is secured to the mooring. Subsequent strings are also secured with their own bridles and cables to the same mooring. Most of the barges in the cluster can be pulled out of the cluster without a major change in mooring lines.

LASH ship arrives in the AOA and begins to off-load barges. Warping tugs assemble those barges into clusters using the side of the LASH vessel as a cluster assembly area. Two warping tugs are required to assemble a cluster in this manner. The tugs then move the cluster to a previously emplaced mooring site, moor it and return to LASH for the next cluster. Four warping tugs or three warping tugs and one LCU can handle the operation.

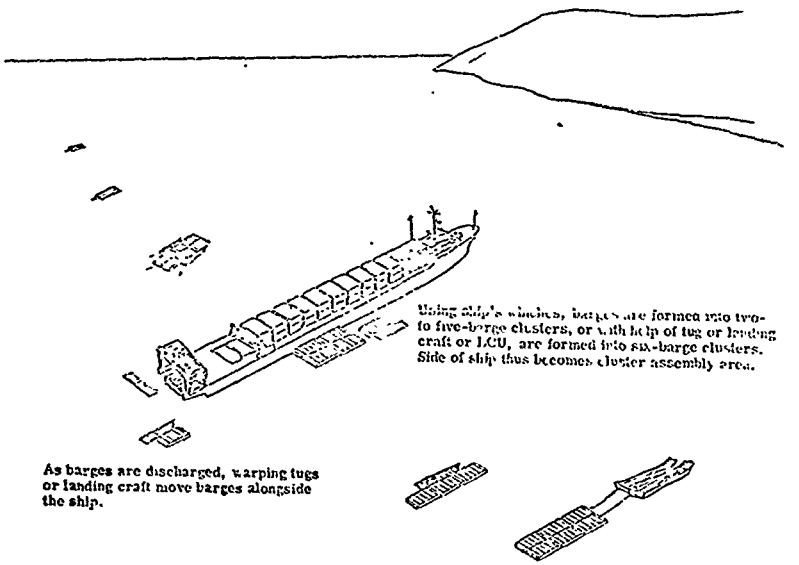


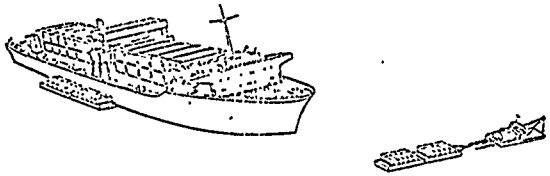
FIGURE B.2

LASH DISCHARGE, FORMING CLUSTERS ALONGSIDE

B.8 Another unique contribution of the LASH ship to the amphibious operation is the ability of the ship to off-load its own containers. This allows a LASH to deliver containers in barge loads mixed with pallets. As a bonus capability, seven 12-ton additional containers can be loaded on the hatch covers of a LASH barge. 1/ Those same barges can also serve as lighters to shuttle the containers ashore to the landing force or serve as an offshore storage area. Additionally, the ship can off-load containers onto causeway ferries, which can accommodate eight containers each. No authenticated data exist regarding use of the ship's container gantry while the ship is anchored offshore; however, it should be similar to the experience of OSDOC I and a number of techniques commonly used by Navy ships. One example is to swing the stern of the LASH ship to windward or against the current to create a lee in the vicinity of the gantry and container cells. This procedure was recommended in the OSDOC II final report for containerships. Based on OSDOC II, it is estimated that container off-loading in sea states up to 3 would be feasible as long as the off-loading is not attempted directly onto a trailer or chassis. Additional information related to LASH discharge of containers is presented in Figure B.3.

B.9 Several Tug Options. The Naval Civil Engineering Laboratory recently conducted tests that utilized landing craft as tugs for barges.

1/ Hatch covers of the present fiberglass LASH barge can accommodate a 150-lb/sq ft surface load. Using conventional dunnage techniques, this allows about 84 tons spread over 168,000 sq ft, or 12 tons per container. It is understood from Northrup, builder of the fiberglass barge, that steps are contemplated to increase the tolerable hatch loading from the current 150 lb/sq ft to 250 lb/sq ft, which would raise the tolerable container capacity to 20 tons each.



C-8 LASH can carry 180 containers below in cells plus 154 topside and on wing walls, bringing the total to 2[illegible]4 containers not loaded in barges. If barges are loaded with mixed pallet-container loads, an additional 343 containers can be transported, bringing the maximum to 677 containers. Broken stowage loss of cube in this mode is minor, and overall cargo-carrying capacity remains about the same as with barges loaded with pallets only.

Using ship's own gantry, ship off-loads containers onto LASH barges, causeway ferries or self-propelled causeways. LASH can off-load containers at the rate of one per [illegible] min.

LASH Barge With Seven Containers Topside. Fiberglass LASH barge with folding hatch covers can accommodate about 150 lb/sq ft loading. This limits individual container weight to 12 tons but allows transport of seven such containers. Once a barge loaded with ammunition is launched, it can accommodate an additional 84 tons topside, with draft of 8.75 ft and freeboard of 3.25 ft.

Two-Section Causeway Ferry With 16 Containers. Each causeway section can accommodate 8 containers. If all containers weigh 14 tons each, causeway draws 3.6 ft with 1.4 ft freeboard. With 10-ton containers, causeways draw 3 ft.

One Self-Propelled Causeway With Second Conventional Causeway, Both With 14 Containers. Similar to option at left. Does not require warping tug; however, self-propelled causeway still under development, thus, this option not yet available in fleet.

FIGURE B.3

EXTERIOR LOADED CONTAINER MOVEMENT FROM LASH

NCEL found that the pontoon warping tug with two 190-hp outboard propulsion units was the most effective and versatile tug in all modes of towing (pull, push, breast) and was able to maneuver and control barges around causeways and other craft. The LCU (1,000 hp) was effective in the pull-tow mode and well suited to long tows. Control and maneuverability of barges, however, by the LCU were poor. The LCM-8 did not appear to be effective for towing loaded barges and demonstrated engine overheating problems at slow towing speeds. The 40-ft utility boat was unsuitable for towing loaded barges. The warping tug and LCU achieved towing speeds of 4 kt. A small, specially fabricated "mini-tug" was also tested. This little craft was assembled in a 3-by-5 pontoon configuration and powered by one 180-hp propulsion unit. The mini-tug proved to be an outstanding towing and handling craft for both loaded and unloaded LASH barges in the push-tow mode, but in the pull-tow mode the craft had difficulty in controlling the tow. [2/] This probably could be corrected by using teams of 2 or 3 of the small tugs on a single job. Figure B.4 shows eight variations in tug options.

Barge Retrieval

B.10 The barge retrieval problem is much the same as that of discharge of the barges, except that the demands on tugs are somewhat different. The empty barges are lighter, which means that a given tug can maneuver more empty barges than full ones. On the other hand, the empty barge is much more sensitive to wind conditions than the

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2/ Naval Civil Engineering Laboratory, Summary of Findings From LASH Barge Tests, 29 May-1 June 1973 and 4-19 September 1973.

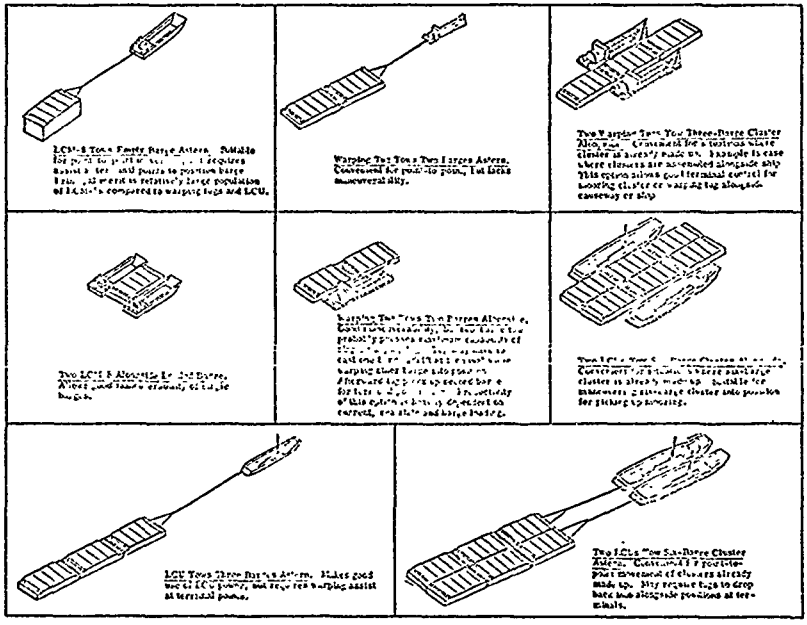
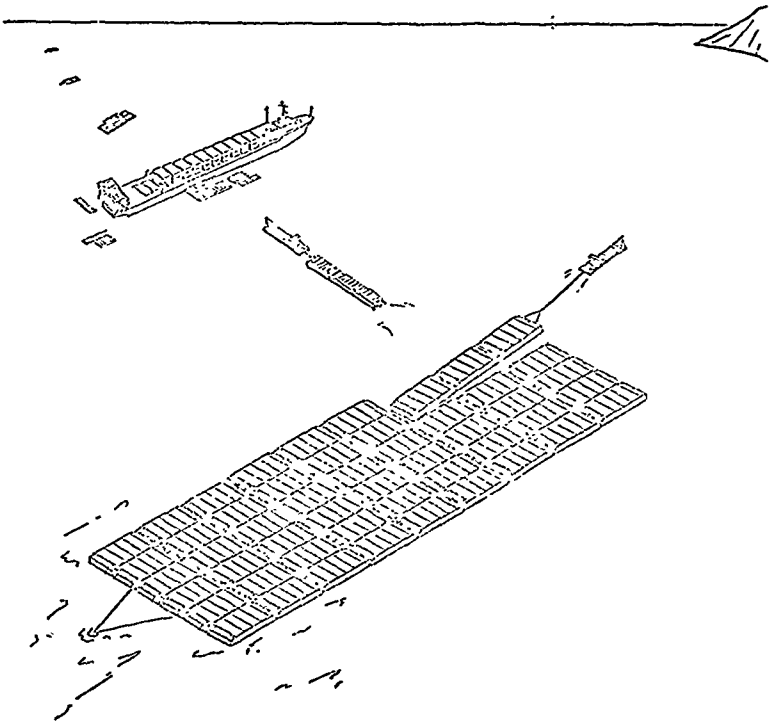


FIGURE B. 4

SEVERAL TUG OPTIONS USING WARPING TUGS, LCU AND LCM-8

loaded one, so that in heavier wind conditions more tug capacity is probably required for empty barges than for loaded barges. Note that, except for the NCEL data cited earlier, required tug capacities and capabilities of landing craft are based only upon estimates by experienced personnel and, since they are estimates, they still require validation in actual fleet tests.

B.11 Figure B.5 shows one technique for temporarily holding groups of empty barges. The main advantage of these large clusters is to centralize the source of empties held for retrieval, thus reducing the number of tugs required. At first glance a 54-barge cluster may appear unrealistic. However, the tonnages represented would be about 6,000 tons for 54 empty barges and up to about 27,000 tons for 54 heavily loaded barges; both cases appear feasible to moor or anchor. Mooring and anchoring problems of empty barges tend to be set by the freeboard area exposed to wind conditions, while loaded barges are affected more by current than wind. Fifty-four empty barges, displacing about 6,000 tons, present less freeboard area than most ships of similar displacement. Fifty-four loaded barges would not appear to pose a significantly more difficult mooring problem than a ship of similar displacement. The important point here, however, is not whether the maximum cluster size is precisely 54 barges (it may be learned later that a realistic upper limit is only 10 or 20) but that relatively large clusters of barges do not now appear to pose disqualifying problems, provided adequate fendering is used. The following paragraphs discuss several factors that bear on this problem.



Empty barges are stored in large clusters near an area where the LASH ship will discharge loaded barges. Tugs shuttle loaded barges to anchorages and empties back to ship. Clusters may be transported to ship and broken down alongside for individual loading. This arrangement would require considerable fendering.

FIGURE B.5

MOORED EMPTY BARGES AWAITING LASH SHIP

MARSHALING

Factors for Consideration

B.12 Cargo Flow. For handling it appears convenient to organize barge clusters into three groups (see Figure B.6). One group consists of those barges from which cargo is being discharged. They are positioned where they are readily accessible to cargo-handling equipment and should be moored close to shore to reduce transit times. The number and size of these "working clusters" is influenced by cargo throughput requirements. Cluster width is constrained by the need for accessibility to cargo from working platforms alongside. A second group consists of barges that have been selected and arranged for efficient movement into the working clusters. These "stand-by" clusters should be moored so that they are convenient to their respective working clusters. The third group consists of holding clusters of loaded and empty barges that are moored to be convenient for rapid movement to and from barge-carrying ships to expedite turnaround of these ships.

B.13 Anchorage Area Utilization. The sizes of barge clusters and the mooring methods will be influenced by topography in the amphibious objective area. Water depth, type of bottom and other factors that influence the size of individual anchorages also influence the optimum cluster length. In 30 ft of water, for example, with a scope of 4:1, the optimum is two barges. Using a scope of 6:1, the optimum length is 5 barges for a 50-ft depth and 10 barges for a 100-ft depth. Individually anchored barges make best use of area only in water depths of less than 15 ft or scope of less than 4:1. Figure B.7 suggests that, with swing moorings in a single area, several different cluster lengths

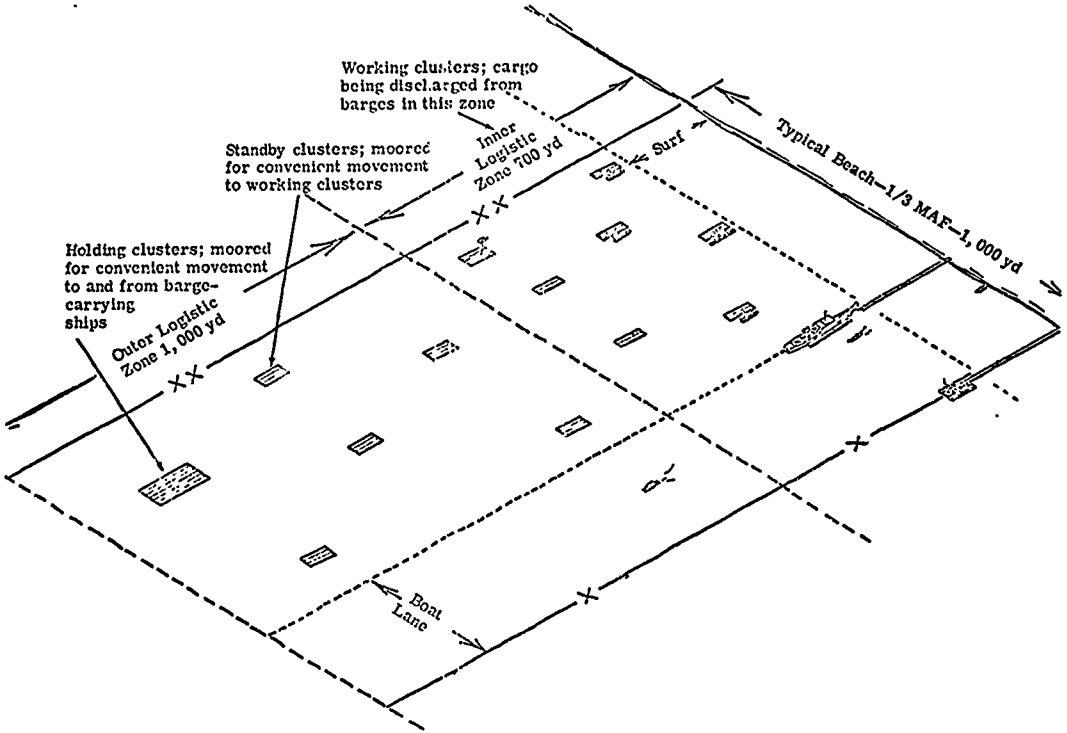
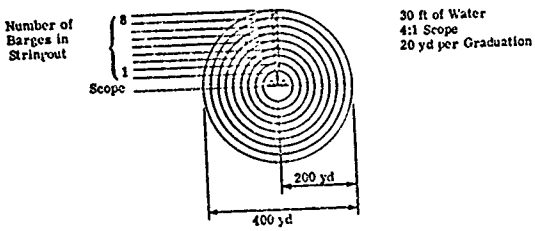


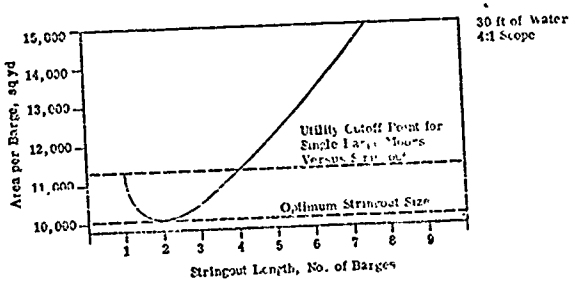
FIGURE B.6

TYPICAL NEARSHORE BARGE CLUSTER ARRANGEMENT

SWINGING CIRCLE FOR BARGE STRINGOUT



AREA UTILIZATION OF STRINGOUT



OPTIMUM STRINGOUT SIZE SENSITIVITY TO DEPTH

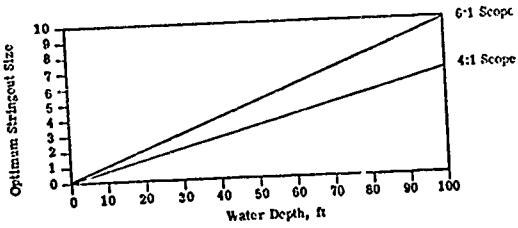


FIGURE B.7

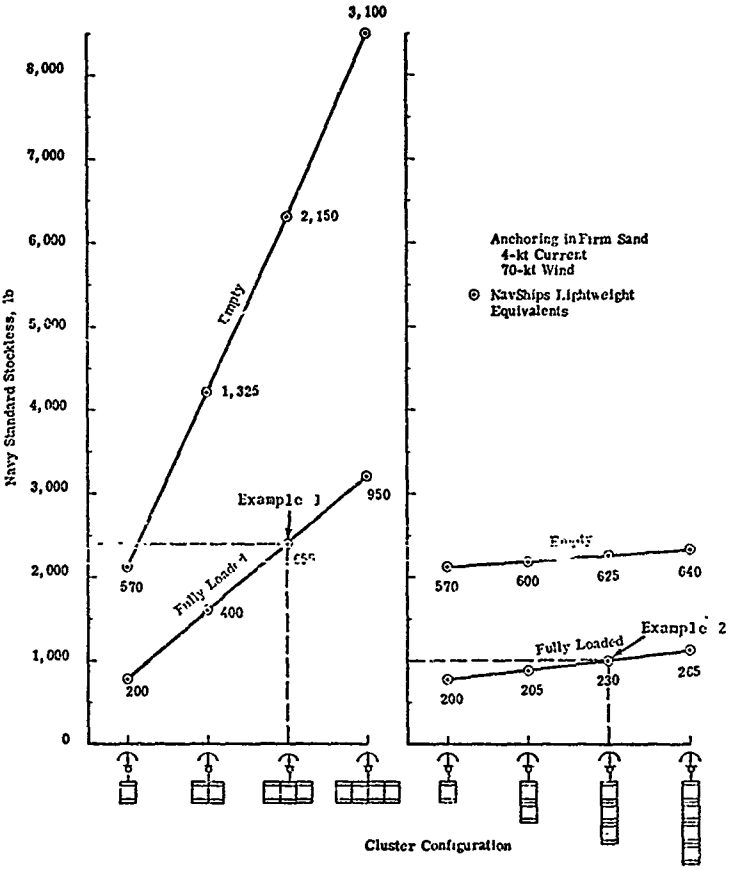
SENSITIVITY OF AREA UTILIZATION TO WATER DEPTH AND SCOPE

tailored to variations in water depth could make best use of available anchorage area.

B.14 Anchor Holding Power. Anchorage area utilization can be improved by increasing cluster width, which is constrained in standby and holding clusters primarily by anchor-holding power requirements. Very little information is available for determining barge anchor requirements, and the subject is being examined by the Naval Civil Engineering Laboratory, Port Hueneme, California. However, data are available on ships that can be used to make gross estimates for barges. Figure B.8 shows the estimated anchor weight needed for various barge cluster widths and lengths. The estimates are based on a 4-kt current and 70-kt wind. Figure B.8 shows that anchor requirements increase directly with increasing cluster width but increase only slightly with increases in cluster length. The figure shows also that empty barges require more anchor-holding power in high winds than fully loaded barges. This is the result of the larger sail area of the empty barges. The anchor requirements used here are based on equations designed to estimate ship requirements; however, these figures are adequate to describe the general effect of cluster size and shape on barge anchor requirements.

Typical Cluster Arrangements

B.15 Five basic barge cluster arrangements are shown in Figure B.9. Each arrangement has unique characteristics that may be advantageous in some situations. Individual barges might be anchored in moderate conditions using the 200-lb NavShips lightweight or NavFac



Example 1: Three barges moored in a side-by-side configuration, presenting a high frontal area, would require a Navy Standard Stockless anchor of about 2,500 lb, while a NavShips lightweight anchor of 700 lb could do the same job. The purpose of displaying the wide frontal area configurations in the graph is to show the great difference in mooring requirements for a wide frontal area in comparison to a narrow, long configuration. As a practical matter, it probably would not be desirable to moor barges one layer deep in the wider configuration. However, larger clusters such as 4-by-4, 4-by-6, 6-by-6 or even larger might demand a wider frontal area cluster.

Example 2: Three barges moored in a bow-to-stern configuration, presenting a narrow frontal area, would require a Navy Standard Stockless anchor of about 1,600 lb, while the NavShips lightweight anchor of about 250 lb would do the same job.

FIGURE B.8

ESTIMATED BARGE CLUSTER ANCHOR WEIGHT REQUIREMENTS

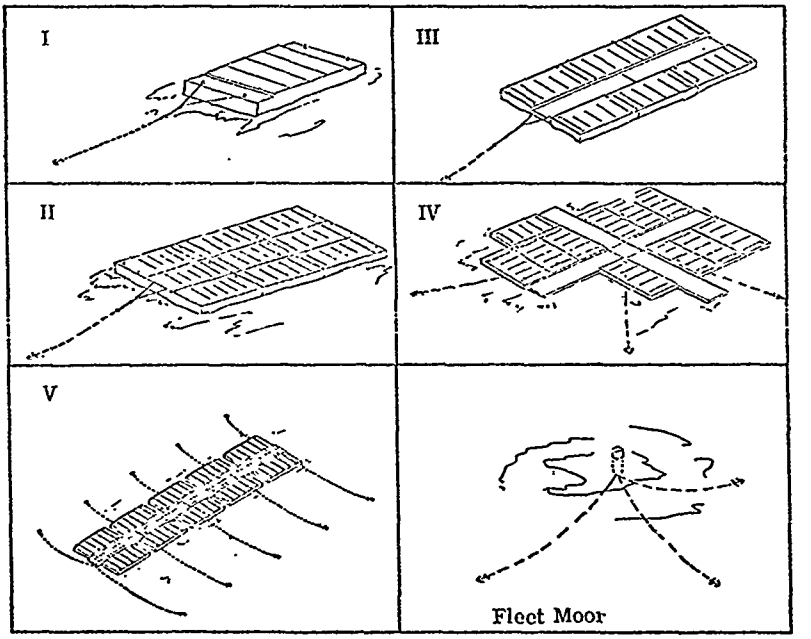


FIGURE B. 9

BARGE CLUSTER ARRANGEMENTS
AND MOORING METHODS

Stato anchors, a popular anchor size in ACB-1 and ACB-2. [3] As indicated earlier, the individual barge anchorage is especially attractive during barge carrier discharge operations.

B.16 Anchoring cargo barges in clusters conserves area, reduces the number of moorings required and simplifies cargo flow paths. However, this approach creates barge mooring and fendering problems and increases anchor-holding power requirements. The use of pontoon causeways as moorings simplifies barge mooring and fendering problems and provides cargo working area, but increases the cost of moorings by the cost of the pontoon causeway. The use of multiple anchor moorings (arrangements IV and V in Figure B.9) or a fleet moor could increase holding power and decrease the anchorage area required, but mooring costs would be higher than single anchor mooring cost. The advantages and disadvantages of these different arrangements are summarized in Table B.1.

B.17 Additional clustering techniques were explored by the Naval Civil Engineering Laboratory in its recent series of tests at Coronado, California. These included a barge string, clustering alongside a causeway, a causeway camel technique, a barge matrix arrangement and a "Christmas Tree" moor. The first four of these are shown in Figure B.10 with the relative evaluation assessed by NCEL. The Christmas Tree moor, developed jointly by NCEL and ACB-1, appears to be the most practical of those yet proposed. In addition, it embodies at least two features that appear to make it superior to those techniques

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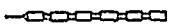
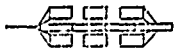
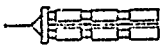
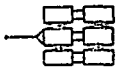
[3] Each ACB unit has ninety-two 200-lb anchors.

TABLE B.1

ADVANTAGES AND DISADVANTAGES OF BARGE MOORING METHODS

Barge Mooring Method	Advantages	Disadvantages
I. Individual anchors (area per barge is 23,600 sq yd, water depth 40 ft, anchor scope 5:1)	– Workable with existing assets – Minimum mooring/fendering problems – Requires no advance mooring emplacement – Could use small anchors (could be emplaced by landing craft) – Attractive for dispersal of ammunition	– Requires excessive area (except in shallow water with conditions suitable for short scope anchoring) – Decreases cargo throughput capacity (complicates cargo flow management and increases transit distances)
II. Anchored cargo barges in clusters (area per barge is 6,600 sq yd, 40 ft, 5:1)	– Workable with existing assets – Requires no advance mooring emplacement – Requires less area than Method I – Better cargo throughput than Method I (fewer cargo storage units to manage and shorter transits) – Attractive for [illegible] cargo to be moved ashore in large load quantities	– Creates mooring/fendering problems – Needs more anchor holding power than Method I – More sensitive to sea conditions than Method I – Swinging cluster may aggravate tug maneuvering when changing barges in cluster
III. Anchored pontoon barges with cargo barges in clusters (area per barge is 5,640 sq yd, 40 ft, 5:1)	– Workable with existing assets – Requires no advance mooring emplacement – Requires less area than Method I – Better cargo throughput than Methods I or II – Fewer cargo storage units and [illegible] – Alleviates mooring/fendering problems of Method II (fenders fixed or pontoon sections) – Less sensitive to sea conditions than Method II – Attractive for assembly of cargo unit loads from two or more barges	– Requires assets not needed in Methods I and II (pontoon causeway sections) – Swinging cluster may aggravate tug maneuvering when changing barges in cluster
IV. Moored pontoon barges with cargo barges in clusters, keystone method	– Workable with existing assets except keystone section – Requires less area than Methods I, II and III – Better cargo throughput than Methods I, II and III (reduced transit distances) – Pontoons provide working area – Can use fixed fenders on causeway sections – Accessibility to cargo in some barges – Cluster could swing on mooring (possible reduce forces tending to break cluster) – Requires fewer pontoon sections than Method V below (this method could moor about 10 LASH barges using 4 pontoon sections)	– Requires keystone section not currently in existence – Requires advance mooring emplacement – Requires more ground tackle than anchored clusters – Portable fenders required for use between barges – Requires assets (pontoon causeway sections) not needed in Methods I and II – Portable fenders required for use between barges – Requires assets (pontoon causeway sections) not needed in Methods I and II
V. Moored pontoon barges with cargo barges in clusters, conventional causeway mooring method	– Workable with existing assets – Requires less area than Methods I, II and III – Better cargo throughput than Methods I, II and III (reduced transit distances) – Pontoons provide working area – Can use fixed fenders on causeway sections (no portable fenders needed) – Accessibility to cargo in all barges	– Requires more ground tackle than anchored clusters in Method IV – Requires more pontoon sections than Method IV (this method could moor about 10 LASH barges using 4 pontoon sections)

Evaluation Parameter	 Barge String	 Alongside Causeway	 Causeway Camel	 Barge Matrix
Ancillary hardware	Low	Low	Moderate	Low/moderate
Maintenance	Low	Moderate	Low	High
Performance	Excellent	Good	Fair	Fair
Cluster emplacement	Excellent	Fair	Fair	Low
Barge selectivity	Poor	Fair	Poor	Low
Space requirement	High	Moderate	Moderate	Low

Source: Naval Civil Engineering Laboratory, Summary of Findings from LASH Barge Tests, 20 May-1 June 1973 and 4-19 September 1973.

FIGURE B.10

FOUR CLUSTERING TECHNIQUES TESTED BY NCEL

described earlier in this appendix. It makes excellent utilization of area and affords easy access to any individual barge in the string. The technique, illustrated in Figure B.11, is built around a standard fleet moor, with a long wire secured to an additional anchor. Spaced along the wire are pendants secured to floats, at sufficient distance apart to allow individual barges to swing a full circle. The result is a string of separate moorings for individual barges that call only for one heavy moor and a simple overall installation.

B.18 Movement of barges in groups nested one barge wide and one to three barges long appears to be convenient for meeting terminal demand and for effective utilization of available tugs. This suggests arrangements for standby clusters and for movement throughout the barge marshaling area. For example, a standby cluster, intended to replenish a terminal that prefers barge exchange in groups of three, might be arranged in clusters of 2 by 3, 3 by 6 and other groupings of 1 by 3 movement units. Movement units made up of specific barges selected from the larger holding clusters might then remain intact throughout most of the operation. Several methods of towing such movement units are shown in Figure B.12.

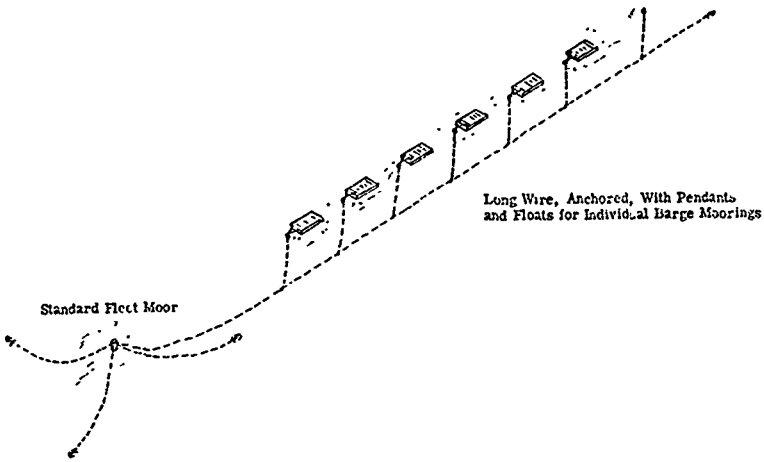


FIGURE B.11

CHRISTMAS TREE MOOR TECHNIQUE
FOR BARGE CLUSTERING

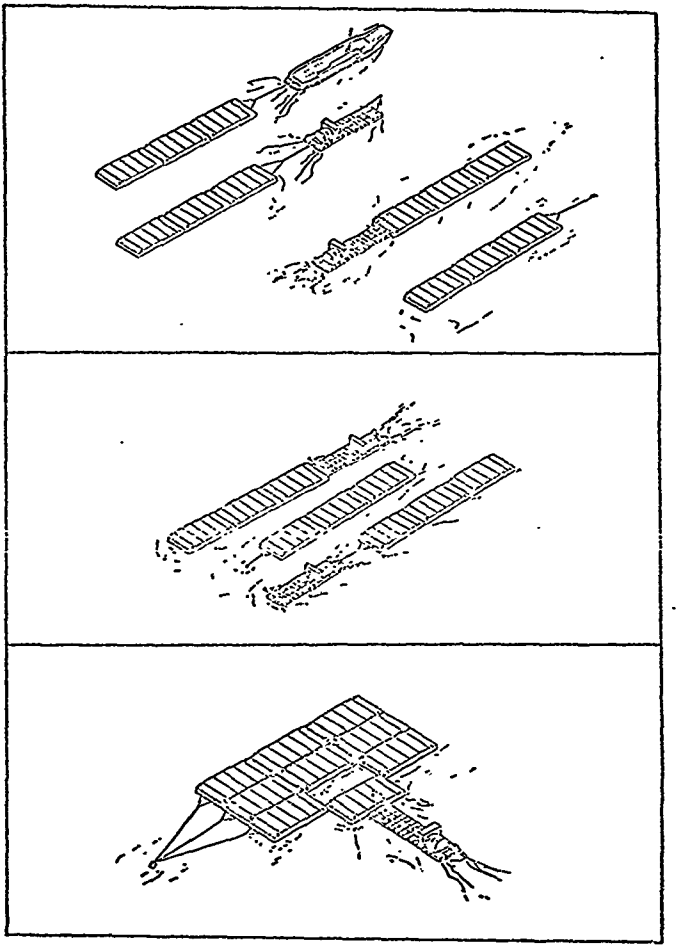


FIGURE B.12
BARGE TOWING METHODS

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13. ABSTRACT

This report summarizes a study of the feasibility and military utility of employing barges offshore to supplement land-based logistics in amphibious operations. Resource requirements including types and numbers of barges and supporting equipment are identified. Problem areas and hardware development objectives are identified, and recommendations for specific action are made.

DD FORM 1 NOV 65 1473 REPLACES DD FORM 1473, 1 JAN 64, WHICH IS OBSOLETE FOR ARMY USE.

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Amphibious logistics						
Amphibious pontoon module (APM)						
Barge cluster						
Bargès						
Collapsible A-frame						
CORONADO tests						
Floating crane						
Inner logistic zone						
LASH						
Logistics						
Outer logistic zone						
Pontoon causeway						
Sea base						
Seabee						
Seaborne Mobile Logistics System (SMLS)						
Shorefast causeway						
Side-loadable warping tug						