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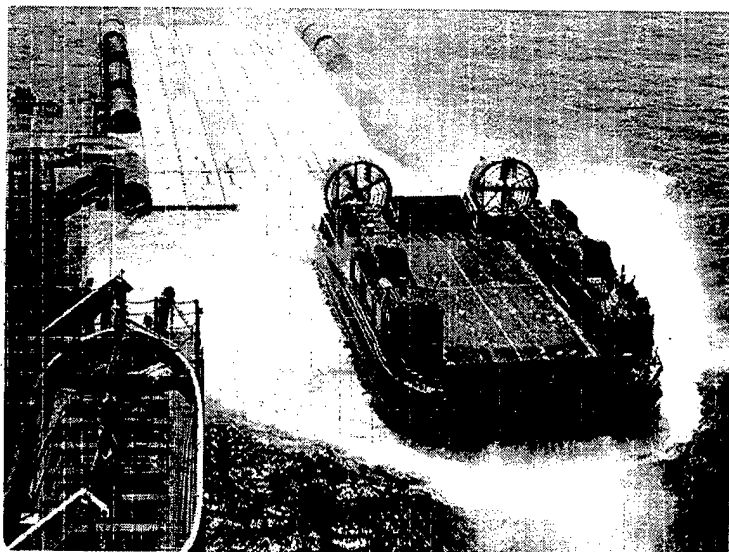
Assessment of the Heavy Lift Landing Craft, Air Cushioned

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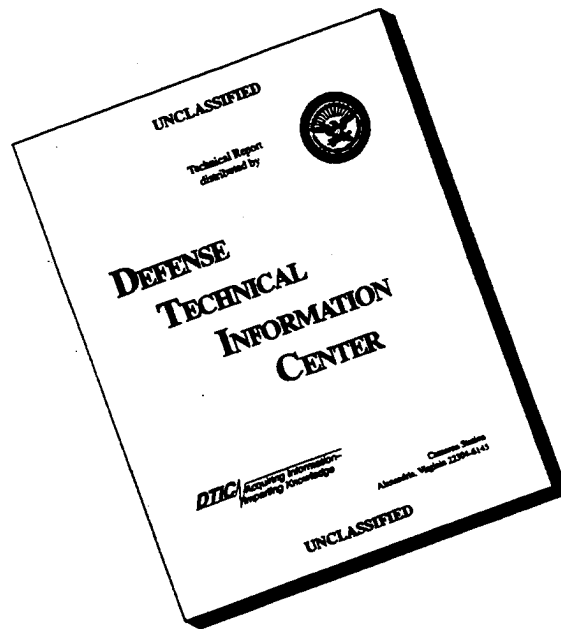DTIC QUALITY INSPECTED A

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Assessment of the Heavy Lift Landing Craft, Air Cushioned

JS502MR2

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LOGISTICS MANAGEMENT INSTITUTE

Assessment of the Heavy Lift Landing Craft, Air Cushioned

Executive Summary

We were tasked by the Director for Logistics, The Joint Staff, to provide modeling and analytical support in assessing the suitability of a proposed Heavy Lift Landing Craft, Air Cushioned (HLLCAC) in Joint Logistics Over the Shore (JLOTS) operations.

The HLLCAC would be a design modification of the current Landing Craft, Air Cushioned (LCAC), recommended by Textron Marine & Land Systems, the manufacturer of this Navy air-cushioned vehicle (i.e., "lighter"). The LCAC is the only air-cushioned lighter in the DoD inventory. Its mission is to support the Amphibious Task Force (ATF). The LCAC will deploy from Navy amphibious ships with equipment and supplies for the Landing Force and deliver gear ashore over unimproved beaches.

The LCAC can operate up to 110 nautical miles from shore with a 65-ton payload. When the distance from shore is 25 nautical miles or more, this is defined as an over-the-horizon (OTH) operation. Conversely, under-the-horizon (UTH) operations are conducted inside the 25 nautical mile mark. The LCAC can carry between 80 and 85 tons when operating under-the-horizon, but at the 85-ton capacity, the lighter is limited to 10 nautical miles or less with one round-trip between refueling. Under optimal conditions (weather and sea state), the inbound speed of the LCAC with 85 tons is 38 knots. The outbound empty speed is 50 knots. Generally, JLOTS will be performed from one to five nautical miles from shore.

Textron claims the HLLCAC design will improve efficiency and increase cargo payload over the LCAC at reduced hourly operating costs. Modifying the LCAC to produce the HLLCAC, to include a later installation of upgraded marine engines, will result in an increased payload capacity of approximately 76 percent. After refurbishing the production line for about $4 million, the manufacturer estimates it will cost $19 million to produce one HLLCAC, $2 million more than the current unit cost of $17 million for the LCAC.

A demonstration conducted by the Navy indicates the LCAC or HLLCAC can perform well in a JLOTS role with the addition of an Air Cushioned Vehicle Landing Platform onto which the lighter will "fly-on" for loading. Without this platform, neither version of the LCAC can currently operate in a JLOTS role. The Navy is reviewing several options for constructing the Air Cushioned Vehicle Landing Platform. One platform is estimated to cost $4.5 million.

We employed the Joint Over the Shore Transportation Estimator (JOTE) model, developed by Logistics Management Institute (LMI), to analyze the impacts of the HLLCAC and LCAC in LOTS and JLOTS operations. For the purpose of analyzing the impact of the HLLCAC on JLOTS operations, a craft mix of two HLLCACs and four LCACs was used. Two HLLCACs were used for the analysis because of the Textron recommendation to convert the last two LCAC production craft to HLLCAC during the manufacturing process. Four LCACs were added because this number plus the two HLLCACs represent the approximate number of air-cushioned lighters that Textron believes can be transported aboard a barge ship.

We looked at the HLLCAC in three settings: Maritime Prepositioned Force (MPF) ship instream discharge and in two (of five) Unified Command's (CINCs 4 and 5) operational planning scenarios for JLOTS operations. These requirements and our modeling results using JLOTS craft (conventional lighters) available in 1995 are documented in another LMI report.[1] The Unified Commands are referred to as CINCs 4 and 5 to keep this report unclassified. In selecting these scenarios, our objective was to identify the effect of the HLLCAC and LCAC when they are added to the mix of conventional lighters available in each operation.

In addition to the number and type of lighters available, two key factors impacting JLOTS are the distance from shore that an operation is conducted and the sea state condition. We used available Defense Mapping Agency nautical charts and Sailing Directions, Naval Oceanography Command sea state data, and commercial port indexes to extract pertinent information, including the distance offshore of water depths of 40 and 80 feet for various locations where operations might be conducted around the world. This information provides an indication of the conditions under which JLOTS operations would be conducted in those areas.

We find the following:

♦ Without the Air Cushioned Vehicle Landing Platform, the HLLCAC and LCAC are not effective in a LOTS or JLOTS role. (Therefore, all subsequent findings and conclusions assume the availability of at least two Air Cushioned Vehicle Landing Platforms).

♦ With respect to Navy and Marine Corps MPF, adding two HLLCAC and four LCAC to MPF instream unloading can result in a reduction of approximately 36 percent in the time required for discharge operations.

♦ With respect to CINC 4, we find the following:

   ► The 40- and 80-foot depth lines average 4.8 and 14.5 nautical miles from shore.

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[1] LMI Report JS502MR1 *Joint Logistics Over the Shore (JLOTS) — An Assessment of Capabilities, JS502MR1,* Peter J. Thede et al., September 1995.

- ► If two HLLCAC and four LCAC are available in Phase I (during the first 10 days of CINC 4 JLOTS operations), the initial 2,000-ton daily throughput shortfall identified in the *JLOTS Assessment* report is eliminated.

- ► The addition of two HLLCAC and four LCAC to the CINC 4 lighter pool increases the Phase II excess daily throughput capacity by approximately 78 percent. Phase II begins after the Phase I initial force reception. The excess capacity during Phase II is available for other CINC 4 JLOTS contingency missions.

- ◆ With respect to CINC 5, we find the following:

  - ► The 40- and 80-foot depth lines average 3.6 and 8.2 nautical miles from shore.

  - ► In all cases, the LCAC makes a more significant contribution than the HLLCAC in reducing the JLOTS throughput shortfall.

  - ► The daily throughput shortfall can be reduced significantly, but not eliminated when the HLLCAC and LCAC are added to the lighter pool.

  - ► When many wheeled vehicles must be moved via roll-on/roll-off (RO/RO) operations, the LCAC makes a significant contribution beginning at the one nautical mile mark.

  - ► Beginning at the one nautical mile mark, the LCAC relieves the Landing Craft, Utility (LCU)-1600 and Army LCU-2000 from work on the wheeled vehicle lanes (based on a combination of LCAC speed, loading and discharge time, and the reduced operating hours due to sea state condition).

  - ► At one nautical mile from shore, adding two HLLCAC and four LCAC to the lighter pool reduces the daily throughput shortfall of 8,271 short tons at Site 1 by 2,242 tons, to 6,029 tons or approximately 27 percent (JOTE selected only the four LCAC to support this mission).

  - ► At one nautical mile from shore, substituting two LCAC (for a total of six) for two HLLCAC in the lighter pool reduces the daily throughput shortfall of 8,271 short tons at Site 1 by 2,944 tons, to 5,327 tons or approximately 36 percent.

  - ► At five nautical miles from shore, the LCAC, in RO/RO operations, can out produce all conventional lighters except the Army Logistics Support Vessel (LSV).

  - ► At the five nautical mile mark, in addition to the LCAC, the HLLCAC begins to be productive; however, the HLLCAC then moves only

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3.4 percent of all cargo carried by the air-cushioned lighter assets at this distance.

► At 10 nautical miles from shore, the HLLCAC, in RO/RO operations, begins to out produce all conventional lighters except the LSV; however, even at this distance, the LCAC remains the JOTE model air-cushioned lighter of choice.

► At one nautical mile from shore, with no restrictions, JOTE selected as the optimal lighter mix 1 LSV, 5 LCACs, and 18 Causeway System, Powered (CSP)+3s giving a shortfall of 5,145 short tons. In optimizing, JOTE selected the most productive craft for this specific operation without limits on the number or mix of lighters available.

► At 10 nautical miles from shore, the JOTE-optimized solution indicates that with 2 LSVs, 8 LCACs and 25 CSP+3s the shortfall remains unchanged at 5,145 short tons.

We conclude the following:

◆ The use of the LCAC in JLOTS operations would make a significant contribution to the total discharge capability, provided the Navy buys the Air Cushioned Vehicle Landing Platforms in sufficient quantities (one per RO/RO Discharge Facility when the LCAC is employed in LOTS or JLOTS operations).

◆ The LCAC is the best air-cushioned lighter in operations under five nautical miles from shore and, depending on the cargo mix, it can out perform the HLLCAC at up to 10 nautical miles from shore.

◆ Because of the additional time required to load and discharge the HLLCAC, it provides only marginal improvement over the LCAC in JLOTS operations conducted at ranges of 5 to 10 nautical miles from shore.

◆ The HLLCAC would be most effective when supporting the Amphibious Task Force beyond 10 nautical miles from shore and in over-the-horizon operations.

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CHAPTER 1

Description of the Heavy Lift Landing Craft, Air Cushioned

INTRODUCTION

We were tasked by the Director for Logistics, The Joint Staff, to provide modeling and analytical support in assessing the suitability of a proposed Heavy Lift Landing Craft, Air Cushioned (HLLCAC), in Joint Logistics Over The Shore (JLOTS) operations. Joint Pub 4-01.6, *Joint Tactics, Techniques, and Procedures for Joint Logistics Over the Shore*, defines Logistics Over the Shore (LOTS)

> ...as the loading and unloading of ships without the benefit of fixed port facilities in either friendly or undefended territory and, in time of war, during phases of theater development. LOTS operations are conducted over unimproved shorelines, through fixed ports not accessible to deep draft shipping, and through fixed ports that are not adequate without the use of LOTS capabilities.

The HLLCAC would be a design modification of the current Landing Craft, Air Cushioned (LCAC), recommended by Textron Marine & Land Systems, the manufacturer of this Navy air-cushioned vehicle. The LCAC is the only air-cushioned lighter in the DoD inventory. Its mission is to support the Amphibious Task Force (ATF). The LCAC will deploy from Navy amphibious ships with equipment and supplies for the Landing Force and deliver gear ashore over unimproved beaches where it is unloaded.

If produced, the Textron HLLCAC variant can be delivered to the objective area using a combination of amphibious shipping and modified Ready Reserve Force (RRF) barge ships. When not supporting the ATF, the LCAC or HLLCAC offer the potential for use in Navy LOTS or JLOTS missions. Our analysis considered the role of the HLLCAC and LCAC and their application in LOTS and JLOTS operations.

The LCAC can operate up to 110 nautical miles from shore with a 65-ton payload. When the distance from shore is 25 nautical miles or more, this is defined as an over-the-horizon (OTH) operation. Conversely, under-the-horizon (UTH) operations are conducted inside the 25 nautical mile mark. The LCAC can carry between 80 and 85 tons when operating UTH; but, at the 85-ton payload, the lighter is limited to an operating radius of 10 nautical miles or less with one roundtrip between refueling. Generally, JLOTS operations will be performed from one to five nautical miles from shore.

HLLCAC CHARACTERISTICS

Textron Marine & Land Systems presented a briefing on comparative features of the LCAC and HLLCAC (the Textron charts contain business-sensitive information and are not included in this assessment). The manufacturer states the HLLCAC can carry a 130 ton payload at a speed of 24 knots (at sea state 2, 100°F) with upgraded marine gas turbine engines. The LCAC upgrade to HLLCAC is meant to increase capability by approximately 76 percent over the current LCAC (maximum payload capacity of 150 tons for the upgraded HLLCAC versus 85 tons for the current LCAC). The manufacturer's new design will reduce fuel consumption, resulting in a decrease of between $500 to $600 in hourly operating costs. A general description of modifications to the basic LCAC design include stretching the LCAC by adding a 40-foot extension, increasing the air-cushion depth to eight feet using an advanced skirt design, increasing usable fuel capacity to 11,000 gallons, and adding a port bow thruster module.

Textron recommends that the last two craft in the current LCAC production run, crafts 90 and 91, be converted to HLLCACs. The estimated modification cost is $8 million. Of this cost, $4 million is for design and production line facilitization and $4 million to produce two HLLCAC. Each HLLCAC is estimated to cost $19 million, or $2 million more than the current unit cost of $17 million for the LCAC.

LCAC IS NOT MODELED IN OUR JOINT LOGISTICS OVER THE SHORE ASSESSMENT

The Logistics Management Institute (LMI) report, *Joint Logistics Over the Shore (JLOTS) – An Assessment of Capabilities* (short title *JLOTS Assessment*), identified which JLOTS lighters would be available for employment in 1995.[1] We did not model the LCAC in that report because the LCAC cannot currently operate effectively in a JLOTS role since the LCAC is restricted to moving cargo directly from and to Navy amphibious ships and not ship-to-shore from standard cargo ships.

One recommendation made in the *JLOTS Assessment* report was for the Navy to acquire the Air Cushioned Vehicle Landing Platform (ACVLAP) as tested in June 1994. Only with this floating platform does the LCAC become an effective JLOTS asset. The ACVLAP enables the LCAC to accept vehicles driven from a ship onto a floating roll-on/roll-off (RO/RO) Discharge Facility (RRDF) and then onto the ACVLAP where the LCAC is positioned for loading or

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[1] LMI Report JS502MR1, *Joint Logistics Over the Shore (JLOTS) – Assessment of Capabilities*, Peter J. Thede et al., September 1995, is a companion to this report, inasmuch as it provides both the Commanders in Chief (CINCs) requirements and our assessment of the conventional lighter fleets ability to satisfy those requirements; thus, it provides a "baseline" assessment, to which we then examine the impact of adding the HLLCAC and LCAC.

unloading. Both the RRDF and ACVLAP are constructed from floating causeway sections and are connected for vehicle traffic with spanners or ramps. It is estimated the ACVLAP will cost $4.5 million each.

At Figure 1-1, we show the RRDF and ACVLAP. In this figure, the stern ramp of a RO/RO ship is resting on the RRDF. An M1A1 tank is on the RRDF moving toward the ACVLAP on which an LCAC is positioned for loading.
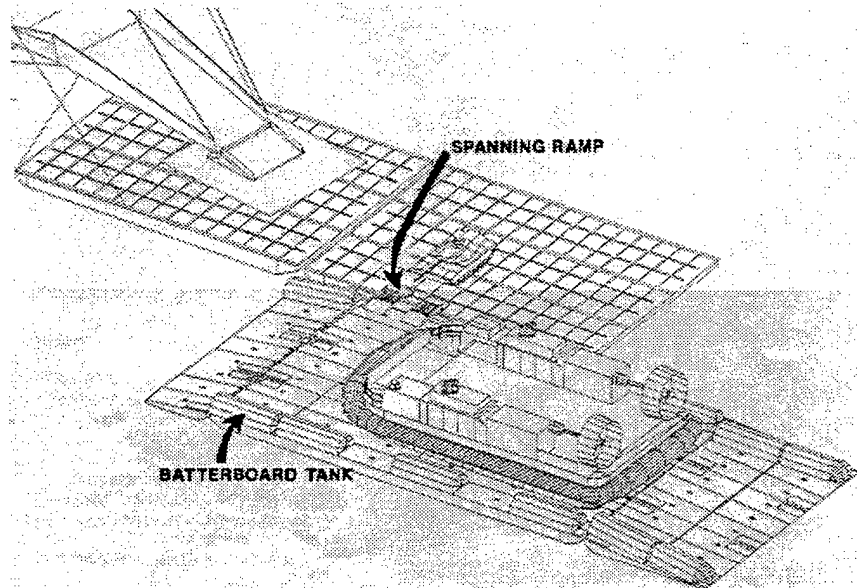
Figure 1-1.
RRDF/ACVLAP/LCAC Configuration for Technology Demonstration

COMPARING THE HLLCAC AND CONVENTIONAL CRAFT

The Textron HLLCAC design characteristics give the craft a maximum cargo capacity of 150 short tons at 12 knots. As noted earlier, the manufacturer states the HLLCAC can carry 130 tons at 24 knots; however, in adding 20 tons to attain its maximum payload of 150 tons, the lighter loses 12 knots in speed. Between the 150- and 130-ton payloads, a representative load for the HLLCAC at 12 knots is two M1A1 tanks at 140 tons. The HLLCAC has deck space remaining with this load but it has capacity for only 10 additional tons. The conventional craft having the nearest comparable capability is the Landing Craft, Utility (LCU)-1600. The LCU-1600 has a speed of 11 knots and a capacity of 187 short tons. The LCU-1600 has both deck space and capacity to carry two M1A1s and additional cargo of up to 47 tons. Unlike the constant speed of the LCU-1600, an HLLCAC has an empty return speed of 50 knots. Thus, the distance from shore at which a JLOTS operation takes place will either somewhat negate or greatly accentuate the HLLCAC speed advantage. This is because the HLLCAC speed advantage has less impact in operations conducted close inshore. However, at greater

distances from shore, the higher speed of the HLLCAC enables it to make more trips per day than conventional lighters. By making more trips per day, the HLLCAC can exceed LCU-1600 productivity.

A picture of the current Navy air-cushioned lighter is in Figure 1-2. If this lighter were to be modified to become a HLLCAC, the hull length would be extended and air cushion depth increased.
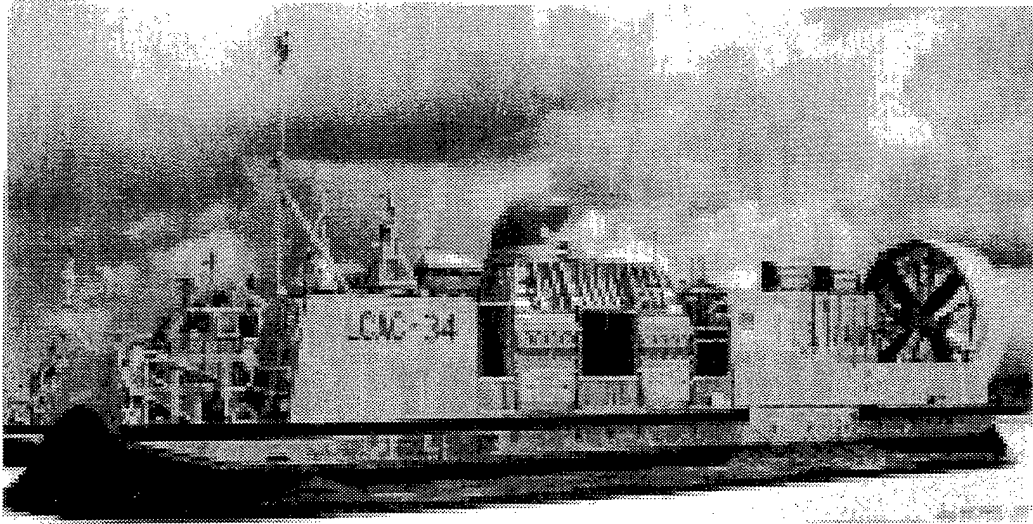
Figure 1-2.
Landing Craft, Air Cushioned

FACTORS AFFECTING JOINT LOGISTICS OVER THE SHORE OPERATIONS DISTANCE FROM SHORE

Currently, JLOTS operations using conventional craft are performed as close inshore as practical. Three factors dictate this practice: ship-to-shore speed, sea state, and 40- and 80-foot shelf.

Ship-to-Shore Speed

The first is the ship-to-shore transit time for conventional lighters. Lighter planning factors show the impact of operations conducted from between one and five nautical miles from shore. Again, using the LCU-1600 as an example, at one nautical mile, the roundtrip transit time is 16 minutes, while at five nautical miles, transit time increases to 1 hour, 20 minutes. With the HLLCAC, speed is determined by the payload carried. For example, at five nautical miles, the inbound leg of a HLLCAC loaded with two M1A1 tanks will take approximately

40 minutes at 12 knots, while the outbound leg will take only 6 minutes at 50 knots. In this instance, the HLLCAC has a total round trip transit time of 46 minutes. Operational considerations dictate whether a HLLCAC payload reduction (one M1A1 tank and a combination of other, less heavy cargo or vehicles) is necessary to fully capitalize on the HLLCAC's speed during both the inbound and outbound legs.

Sea State

The second, and most important, reason for conducting JLOTS close inshore is sea state condition. Higher sea state (SS) conditions (SS3 and above) are found with more frequency the further from shore an operation is conducted. As stated in the *OCEAN VENTURE 93 JLOTS III Throughput Test Report*, "the inherent risks of operating in sea state three are not worth the minimal productivity and possible equipment damage which could occur".[2] Currently, sea state will limit the LCAC and HLLCAC in a JLOTS role. While the lighter is capable of operating from amphibious shipping in SS3 conditions, the HLLCAC is restricted to operations in SS2 or below for JLOTS. The HLLCAC and LCAC advantage of greater operating flexibility is constrained by the reduced sea state capability and sea worthiness of its associated systems: the RRDF and ACVLAP. The LCAC and HLLCAC will regain full operational capability in JLOTS should the Navy's Advanced Technology Demonstration for an advanced lighterage system be successful and result in the acquisition of a floating causeway (RRDF and ACVLAP) capable of SS3 operations.

The 40- and 80-Foot Shelf

The draft of sealift ships is the third determinant in establishing the distance from shore at which JLOTS operations are conducted. A minimum water depth of 40 feet is usually necessary. Some ships will need to anchor in deeper water or vessel masters may require an additional safety margin when charts are outdated or hazards to navigation are present. Thus, the most likely range for establishing JLOTS berths is in water at depths of between 40 and 80 feet. Beach gradient and water depth will determine how far from shore JLOTS is performed. The steeper the gradient, the closer inshore sealift ships can anchor.

We used available Defense Mapping Agency nautical charts and Sailing Directions, Naval Oceanography Command sea state data, and commercial port indexes to extract pertinent information, including the distance offshore of water depths at 40 and 80 feet, for various militarily useful locations around the world. This information provides an indication of the conditions under which JLOTS operations would be conducted in those areas. We included localities designated as major regional conflict areas and countries where lesser regional conflicts, peacekeeping or operations other than war might be conducted. In addition to information in Table 1-1, data on these areas are found in Appendix A.

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[2] U.S. Transportation Command, Joint Test Directorate, *JLOTS III Throughput Test, Ocean Venture 93*, May 1994.

Table 1-1.
Navigation and Climate Data

Command area	40-foot mark[a] (average distance from shore in NM)	80-foot mark[a] (average distance from shore in NM)	Sea state (average percentage of time at various levels)
CINC 4	4.8	14.5	SS0 and SS1 = 60% SS2 = 16% SS3 or > = 24%
CINC 5	3.6	8.2	SS0 and SS1 = 53% SS2 = 17% SS3 or > = 30%

Note: NM = nautical miles

[a] Actual distance from shore will be dependent on the specific operational area selected. See Appendix A.

MODELING LCAC AND HLLCAC PERFORMANCE

The LMI Joint Over the Shore Transportation Estimator (JOTE) model was used to evaluate LCAC and HLLCAC performance. Planning factors for conventional craft were developed from the JLOTS II and OV93 JLOTS III tests. Planning factors for the HLLCAC and LCAC were developed for JOTE using Annex E (unclassified) of the 1990 Department of the Navy *Integrated Amphibious Operations and USMC Air Support Requirements Study* (DoN Lift Study), cycle time data from the June 1994 ACVLAP demonstration conducted by the Naval Surface Warfare Center's Carderock, MD., Division; and HLLCAC performance characteristics provided by Textron. Data from the Carderock demonstration is found in Appendix B.

For the purpose of HLLCAC modeling, a craft mix of two HLLCAC and four LCAC was used. The two HLLCAC were identified based on the Textron recommendation to convert the last two LCAC production craft to HLLCAC during the manufacturing process. Four LCACs were added because this number and the two HLLCAC represent the number of air-cushioned lighters Textron believes can be transported aboard a barge ship.

The first step in JOTE modeling was to establish a benchmark by determining what advantage the LCAC and HLLCAC brought to a purely Navy and Marine Corps LOTS operation. In this instance, the LCAC and HLLCAC are in addition to the Navy Lighterage Causeway System, Powered (CSP)+2 and Landing Craft, Mechanized (LCM)-8 now available.

Next, the LCAC and HLLCAC were modeled in JOTE with conventional Army and Navy lighters. The focus for this part of the HLLCAC modeling task was CINCs 4 and 5 and their JLOTS requirements identified in the *JLOTS Assessment* report. The JOTE modeling employed Unified Command JLOTS

requirements found in the *JLOTS Assessment* report. In modeling the LCAC and HLLCAC, it was assumed that up to two ACVLAPs would be available. We include a short description of the various lighters in Appendix C of this report. Also at Appendix C are notional diagrams of JLOTS areas using JLOTS in fixed port augmentation and bare beach scenarios. The diagrams depict one way in which JLOTS might be conducted.

The "standard day" LCAC vehicle loads from Annex E of the DoN Lift Study and lighter characteristics from the Textron briefing were used to model LCAC and HLLCAC performance. The planning factors developed for JOTE are shown in Table 1-2. Although the payload weights do not represent the maximum capacity of the LCAC or HLLCAC, we selected Textron data and the DoN Lift Study standard to retain the speed inherent with operation of air-cushioned craft.

Table 1-2.
HLLCAC and LCAC Standard-Day Vehicle Loads

Vehicle	Temperature	Sea state	Average payload (short tons)	Load/unload time	Inbound/ outbound speed (knots)
HLLCAC	60 – 80°F	SS2	92.2 S/T	37/20 min.	33/50
LCAC	60 – 80°F	SS2	75.0 S/T	30/16 min.	25/50

We include a short description of JOTE and its capabilities in Appendix D.

Heavy Lift Landing Craft, Air Cushioned Analysis

NAVY AND MARINE CORPS MARITIME PREPOSITIONED FORCE LOGISTICS OVER THE SHORE

We began JOTE modeling to first establish the relative value of employing the LCAC and HLLCAC in a Navy and Marine Corps Maritime Prepositioned Force (MPF) instream discharge operation. For this purpose, we used Headquarters, Marine Corps data for a single, representative ship in one MPF squadron. The ship contains 11,997 short tons of cargo. The cargo configuration for that ship is

◆ 1,269 tons of tracked vehicles,

◆ 2,950 tons of wheeled vehicles, and

◆ 7,778 tons of containers (20-foot equivalent units [TEUs]).

Our first objective was to model the time (in days) required to discharge this ship using conventional lighterage loaded aboard MPF ships. All lighters assigned to the MPF squadron were made available for cargo discharge operations. The lighter pool consists of 8 LCM-8s, 16 CSP+2s, and 1 roll-on/roll-off (RO/RO) Discharge Facility (RRDF). An operational readiness (availability) rate of 85 percent was assigned to all craft, shipboard cranes, and the RRDF. The sea state was SS2 or less 53 percent of the time. A two-shift, 24-hour operation was conducted with each shift working 10 hours which provided 20 hours of productivity in a day. The operation was conducted one nautical mile from shore. The number of simultaneous discharge lanes assigned were three lift-on/lift-off (LO/LO) and two RO/RO lanes. Once the wheeled and tracked vehicles were unloaded, the two RO/RO lanes were converted to RO/RO container lanes using Logistics Vehicle Systems (LVS) and Rough Terrain Container Handlers (RTCH) to move containers aboard ship and onto lighters. Each LVS will carry two TEUs. A pool of LVSs was used for this operation with empty vehicles returning to the ship aboard subsequent lighter rotations.

Next, we made an excursion by adding two HLLCAC and four LCAC to the current MPF lighter group. Although the LCAC is not manned for 24-hour operations, we assumed that it was so manned for our analysis. Thus, in this case, the objective was to determine if, and by how much, the LCAC and HLLCAC produced a reduction in the number of days required to discharge the representative MPF ship.

We followed this with an excursion wherein we replaced the two HLLCAC and four LCAC with six LCU-1600s. Our objective was to determine how the offload using this conventional lighter compared with the air-cushioned lighters.

NAVY AND MARINE CORPS MARITIME PREPOSITIONED FORCE LOGISTICS OVER THE SHORE MODELING RESULTS

From the 16 CSP+2s available in the MPF squadron, JOTE utilized 8 for unloading the ship. None of the 8 LCM-8s were selected by the model to move LOTS cargo; however, these lighters are routinely employed as working boats and command and control platforms (the LCM-8 can also be effective when moving vehicles from LOTS sites close inshore). After the rolling stock was discharged, we placed some of the container surplus on the RO/RO lanes to be moved using RTCHs and LVSs. Although modeling results show that the sea state had a significant impact on unloading, we found that even under these adverse conditions, approximately 530 short tons of containers (42 TEUs) could be discharged daily on each of the RO/RO lanes.

For MPF instream discharge, we found the following:

◆ JOTE modeling indicates that, using only conventional MPF lighters, it takes five days to discharge the rolling stock of one MPF ship under these sea state conditions (i.e., greater than SS2 47 percent of the time) and 11 days to complete ship unloading.

◆ The 12,000 tons on the ship we modeled can be unloaded instream with conventional lighters in under six days if sea state conditions remain at SS2 or below.

◆ When two HLLCAC and four LCAC were added to the lighter mix, the rolling stock was unloaded in the first two days versus five days with conventional lighters, and the entire MPF ship was discharged in seven days, a reduction of four days or 36 percent. *That is, in constant SS2 or below conditions, the MPF ship in our model can be unloaded in just under four days if the HLLCAC and LCAC are used.*

◆ When six LCU-1600s replaced the two HLLCAC and four LCAC, the rolling stock was again unloaded in the first two days versus five days (with the same 36 percent reduction in total time when only Navy causeway lighters are employed). These results indicate that any addition of LCUs would also improve MPF offload.

By way of comparing our modeling results with actual performance, we looked at data from an actual MPF instream discharge exercise. We reviewed the results from Freedom Banner 87, as reported in the 1990 Center for Naval Analysis (CNA) Research Memorandum 89-399, *MPF Exercise Summary.* Freedom Banner 87 represents the best instream discharge performance of all exercises

observed by CNA analysts. In that exercise, a partial instream discharge from two ships was tested. This partial discharge operation was conducted under ideal weather and sea conditions. Ships were in a protected anchorage and ramps were in place on the beach. Unloaded were 926 vehicles and 687 containers (i.e., approximately 14,000 short tons). The average discharge rate for the two ships was 6 vehicles and 4.2 containers per hour. This translated into an hourly beach reception rate of 12 vehicles and 8.4 containers. Given this observed production rate, vehicles would be unloaded in 77.2 hours and containers in 81.8 hours. When converting these rates to the 20-hour work days used in our analysis, this corresponds to 3.9 days for vehicles and 4.1 days for containers, just over 4.0 days overall. Although our model produced an offload in approximately 6 days using conventional lighters, the results are roughly consistent when one considers that the modeled sea state conditions were not as benign as the actual conditions experienced in Freedom Banner 87.

JOINT LOGISTICS OVER THE SHORE IN CINCs 4 AND 5

After establishing the relative value of employing the LCAC and HLLCAC in Navy LOTS operations, we next integrated these craft into the *JLOTS Assessment* modeling for CINCs 4 and 5.

CINC 4

From the *JLOTS Assessment* report, CINC 4 has a peak total daily requirement of 8,010 short tons. Two JLOTS sites are in operation and five ships are at JLOTS berths. Together, these five ships have 17 discharge lanes. Sea state conditions are SS2 or below 60 percent of the time. Again, a two-shift, 20 productive-hour day was used. The operational availability factor for lighters, cranes, RRDF, and ACVLAP was set at 85 percent. The CINC 4 daily cargo throughput requirement is

- 1,475 tons of tracked vehicles,

- 4,361 tons of wheeled vehicles,

- 1,615 tons of TEUs, and

- 559 tons of noncontainerized cargo.

From the *JLOTS Assessment* report, the JOTE model selected 3 Logistics Support Vessels (LSVs), 7 LCU-2000s, 6 LCU-1600s, and 8 CSP+2s to move the 8,010 tons daily. Our modeling objectives were

- to determine if the HLLCAC and LCAC eliminated the CINC 4 initial throughput shortfall (first 10 days); and

- because the CINC 4 daily cargo throughput requirement could be met by the craft selected in the *JLOTS Assessment* report, to determine what additional daily throughput capacity the two HLLCAC and four LCAC provided.

CINC 5

The CINC 5 daily JLOTS throughput requirement is 26,799 short tons. Although subsequent discussions with CINC 5 planners reveal that this large daily requirement may ultimately be reduced, all component JLOTS requirements have not been identified. As such, we elected to continue with the data originally provided by this Unified Command for the *JLOTS Assessment*. Part of the CINC 5 daily JLOTS requirement is to move 20,279 tons of cargo at a single site (Site 1). During this most demanding period, Site 1 and a second site are in operation. Between the two JLOTS sites, JOTE modeled up to 16 ships being worked simultaneously. For these 16 ships, a total of 48 RO/RO and LO/LO lanes were established. The major impact on productivity was the sea state in this region (i.e., SS2 or higher 47 percent of the time). The *JLOTS Assessment* report showed that simply adding additional lighters would not close the shortfall gap. In addition to sea state, several factors influence the operation. They include the availability of sealift ships and cargo-handling units needed to operate the required JLOTS berths. The CINC 5, Site 1 daily cargo throughput requirement is

- 3,998 tons of tracked vehicles,

- 11,820 tons of wheeled vehicles, and

- 4,461 tons of TEUs.

The JOTE modeling from the *JLOTS Assessment* report indicated that 3 LSVs, 18 LCU-2000s, 6 LCU-1600s, 6 LCM-8s, 4 CSP+3s, 18 CSP+2s, and 2 CSP+1s could move just over 52.4 percent or 13,777 tons of the daily, two-site, throughput requirement. Site 1 had a shortfall of 8,271 short tons out of the 20,279 tons of cargo to be moved at that site. For CINC 5, our modeling objectives were

- to determine the relative productivity of each lighter type at several distances and the "cross-over points" in productivity,

- to establish whether the LCAC and HLLCAC contributed to reducing the daily throughput shortfall, and

- to show the optimal lighter fleet to eliminate or minimize the shortfall for CINC 5 at Site 1.

Joint Logistics Over the Shore Modeling Results for CINCs 4 and 5

CINC 4

With the exception of the first 10 days, JLOTS requirements were met with lighters already available to CINC 4. The majority of cargo moved for CINC 4 was tracked and wheeled vehicles. On the basis of the cargo mix modeled, some additional lighter capacity was available but not used. This excess capacity equals 1,722 short tons per day.

♦ If the HLLCAC and LCAC are available during the early CINC 4 Phase I requirement period (the first 10 days of reception operations), there will be no initial 2,000-ton daily shortfall, as reported in the *JLOTS Assessment* report.

♦ By adding two HLLCAC and four LCAC, the Phase II (post-initial force reception) additional daily throughput capacity (available for other JLOTS missions) increases by 6,141, (in RO/RO capacity) to 7,863 tons.

CINC 5

As noted above, we focused CINC 5 modeling on Site 1 where 20,279 tons per day are to be moved. JLOTS's Site 1 for CINC 5 requires the discharge of a significant number of vehicles. Because of the large shortfall in meeting CINC 5 requirements with existing conventional lighters, we did several excursions to expand our analysis of the HLLCAC and LCAC with conventional lighters. For CINC 5, we conducted JOTE excursions at 1-, 3-, 5-, 10-, 15-, and 20-nautical miles.
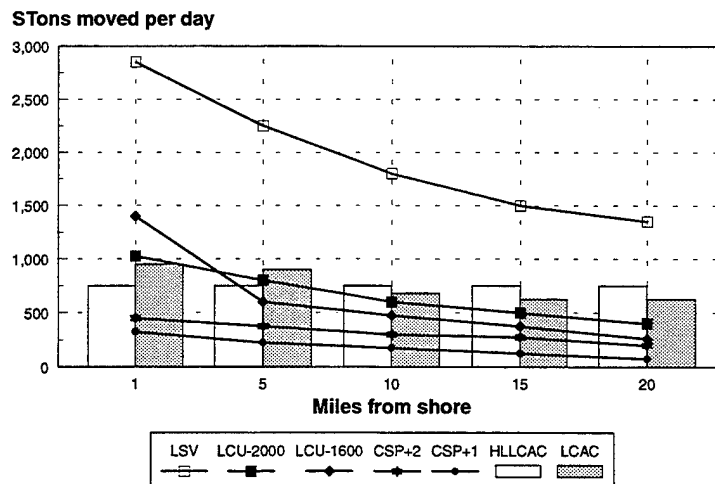
Figure 2-1.
Comparison of the HLLCAC, LCAC, and Other Lighters for CINC 5, Site 1

In Figure 2-1, we see that the productivity (using the "standard day" factor) of the HLLCAC and the LCAC change little as the distances increase. Conventional lighters, on the other hand, exhibit a significant decrease in average daily cargo throughput as the distance from ship to shore increases. The various daily lighter tonnages are plotted at the 1-, 5-, 10-, 15-, and 20-nautical mile marks for CINC 5, Site 1. The smaller payload of the HLLCAC and LCAC relative to other lighters translates to less overall productivity than conventional lighters at short ranges, but the superior speed of the HLLCAC and LCAC can make them better performers depending on the cargo mix to be moved as well as on the distance involved.

◆   When integrating the LCAC and HLLCAC into the discharge operation, we found that the LCAC was selected more than the HLLCAC inside the five-mile mark.

This is analogous to the relationship between the LCU-2000 and the LCU-1600. Although the LCU-2000 has a much larger capacity, the LCU-1600 can perform more trips per day. Hence, when close inshore, the LCU-1600 is often selected over the LCU-2000 to maximize productivity for LOTS discharge.

The following results are based on the lighterage and cargo for CINC 5; by changing the underlying lighter mix, the relative performance would, of course, change. Also, results would be quite different under a different scenario (e.g., amount and mix of cargo, sea state, etc.).

◆   Productivity differences between the HLLCAC and LCAC are not great; however, for CINC 5, Site 1, the relative superiority transfer between the LCAC and the HLLCAC changes between the five and ten nautical mile mark.

◆   At the one nautical mile mark, the LSV, LCU-2000, LCU-1600, and LCAC are the biggest producers, but discharge at five miles sees the LCAC beginning to out produce everything except the LSV. By the 10 nautical mile mark, the HLLCAC out produces all conventional lighters except the LSV. The LSV is still the biggest producer at the 20-nautical mile range. Our analysis indicates the HLLCAC overtakes the LSV at around the 50 nautical mile mark — well outside the conventional JLOTS range.

Table 2-1 displays the differences in shortfall at the 1-, 3-, 5-, and 10-nautical mile marks when combinations of lighters are used.

Table 2-1.
Shortfall in Short Tons for CINC 5, Site 1

Nautical miles	Base case	Four LCAC and two HLLCAC	Six LCAC	Optimized[a,b]
1	8,271	6,029	5,327	5,145
3	8,306	6,259	5,334	5,145
5	8,496	6,453	5,568	5,145
10	8,922	7,117	6,285	5,145

[a] In reducing the shortfall to the lowest possible level, JOTE selected the optimum mix of lighters without restrictions on the number or type of craft available at various distances from shore.

[b] Optimized discharge productivity does not decrease because the offload rate is constant regardless of distance from shore when more lighters are added to the pool.

The base case consisted of the conventional lighters available for CINC 5 from the *JLOTS Assessment* report. The four LCAC/two HLLCAC case is when, *in addition to* the craft available in the base case, the JLOTS commander has access to these lighters for JLOTS operations. The six-LCAC case is where the commander has six LCACs to use for JLOTS operations in addition to the base case, conventional lighter mix.

♦ Significantly, the inclusion of the HLLCAC and LCAC, when operating from one nautical mile, reduces the CINC 5 shortfall at Site 1 from 8,271 to 6,029 tons.

♦ More significantly, the introduction of six LCAC (instead of a mix of HLLCAC and LCAC) into the base case reduced the shortfall from 8,271 to 5,327 short tons at one nautical mile.

A graphic display of these results is found in Figure 2-2.
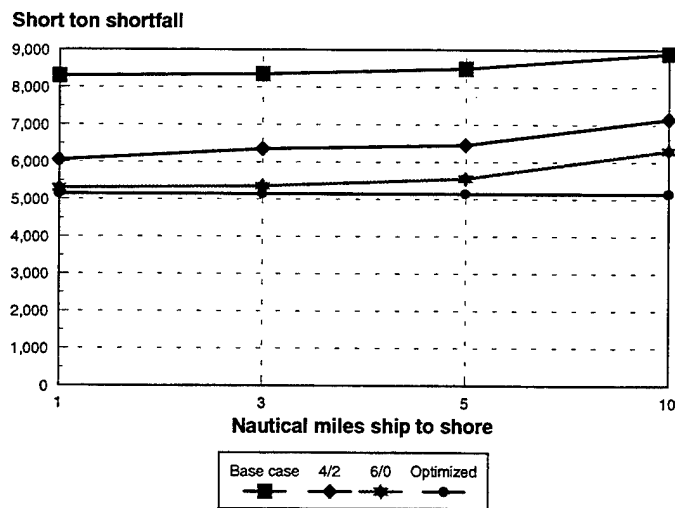
Figure 2-2.
Shortfalls for CINC 5 Using Various Configurations of Lighters

In the optimized case (no restrictions on the number or type of lighters), JOTE was allowed to select the optimal mix of lighters as well as assign these lighters to lanes. Optimization is based on type of cargo, available lanes, and lighter equipment readiness rates. The optimized case used specific craft for each of the missions presented by CINC 5. When possible, the model employed the LSV to discharge tracked vehicle RO/RO lanes, the LCAC to discharge the RO/RO-wheeled vehicle lanes, and the CSP+3 to move the LO/LO container and breakbulk cargo. The results are the following:

♦ The CINC 5, Site 1, shortfall can be significantly reduced but not eliminated.

♦ At one nautical mile from shore, with no restrictions, JOTE selected 1 LSV, 5 LCACs, and 18 CSP+3s as the optimal lighter mix, giving a shortfall of 5,145 short tons.

♦ If not allowed to use the CSP+3, the optimal mix is 24 LSVs and 5 LCACs, giving a shortfall of 5,175 short tons.

♦ If neither the CSP+3 nor the LSV are available, the optimal choice for a lighter fleet is 28 LCU-2000s and 6 LCACs, with a shortfall of 5,418 short tons.

♦ At 10 nautical miles from shore, the JOTE-optimized solution indicates that with 2 LSVs, 8 LCACs, and 25 CSP+3s, the shortfall remains unchanged at 5,145 short tons.

The optimized lighter mix is shown in Table 2-2.

Table 2-2.
Optimized Lighter Mix, Site 1 at the One Nautical Mile Mark

Lighter pool	Lighters selected	Shortfall (short tons)
All – no restrictions	1 LSV 5 LCACs 18 CSP+3s	5,145
No CSP+3	24 LSVs 5 LCACs	5,175
No CSP+3 and No LSV	28 LCU-2000s 6 LCACs	5,418

In conducting this assessment, we optimized the HLLCAC and LCAC loading for JLOTS operations. In order to draw a comparison of the LCAC and HLLCAC performance data we selected for analysis, we used the largest load at which high speed is maintained. This criteria is based on the manufacturer's data. In Table 2-3, the capacity of the two lighters is raised to 85 and 130 tons, respectively. A corresponding decrease in speed and increase in loading and

unloading time is also shown. It should be noted that to carry this maximum-rated capacity at the speed indicated requires an ambient air temperature of 100°F. Based on average temperatures found at the various locations we identified in Appendix A, it will seldom be possible to expect temperatures being this high.

Table 2-3.
LCAC and HLLCAC at High-Speed and Maximum Capacity

Vehicle	Temperature	Sea state	Average payload (short tons)	Load/unload time	Inbound/ outbound speed (knots)
HLLCAC	100°F	SS2	130 S/T	43/23 min.	24/50
LCAC	100°F	SS2	85 S/T	34/18 min.	24/50

The result of maximizing capacity, while retaining speed as shown in four LCAC/two LLCAC (4/2) special in Figure 2-3 below, is that the shortfall *increased* in comparison to either the 4/2 or all-LCAC examples shown at Figure 2-2. This occurs because loading air-cushioned craft to their maximum capacity, *in a JLOTS operation,* is not their optimum load when used in conjunction with conventional craft. The time needed for loading and unloading now becomes a more important factor relative to the capacity of these lighters versus conventional lighters with greater capacity. Figure 2-3 shows how the shortfall increased when the HLLCAC and LCAC were loaded to the greater capacity.
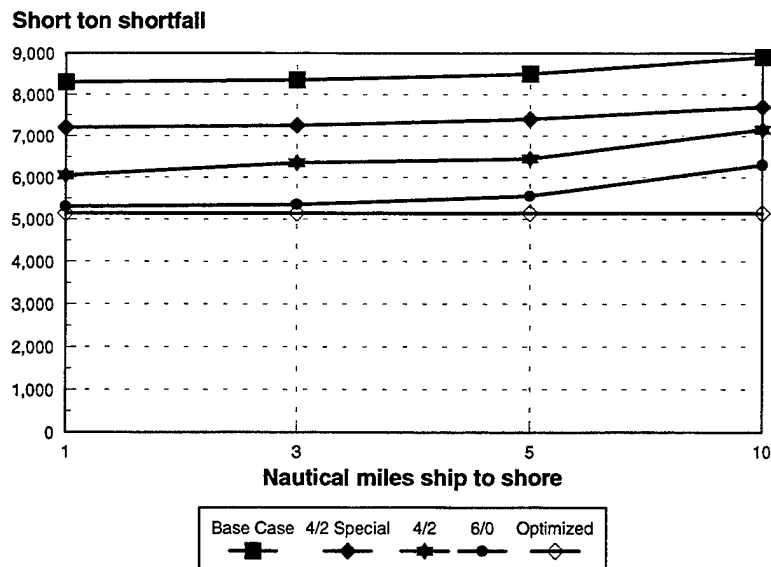
Figure 2-3.
Shortfalls for CINC 5 with LCAC and HLLCAC at High-Speed and Maximum Capacity

2-9

Lighter Interactions and Marginal Benefit of the HLLCAC

Up to a certain distance from shore, our modeling in CINC 4 and CINC 5 to this point suggested that the HLLCAC's benefit was only marginal in a JLOTS role. A key point is that the interactions between various lighter types is very important in determining overall production. To further clarify our analysis, we did an additional excursion for CINC 5. We modified the requirement for the RO/RO-wheeled vehicle lanes so that they could be completed in a single day. We again modeled the same two air-cushioned vehicle configurations using this modified requirement.

First, we modeled four LCAC and two HLLCAC. Then, we changed this to just six LCAC. The results are displayed in Figure 2-4. The overall productivity of the air cushioned landing craft *decreased* when going from four LCAC and two HLLCAC to six LCAC. Since in our previous modeling the LCAC individually out produced the HLLCAC, one would think that by replacing the two HLLCAC with LCACs, the total production for the air-cushioned vehicle fleet would have increased. We see, however, that production actually declined. This occurred because of the *interaction* between the conventional lighter fleets and the air-cushioned fleets. When the HLLCACs were present, they took just enough tonnage from the tracked vehicle lane to allow the LSVs and LCU-2000s to complete discharge on the RO/RO-tracked vehicle lane. In this way, the overall *site* is more productive, but each individual LCAC carries *less* than its full capacity. From this excursion, our assessment is confirmed that the HLLCAC can be a productive close-in JLOTS asset, but it is only marginally so even when all factors are favorable.

Short tons moved by air-cushioned fleet
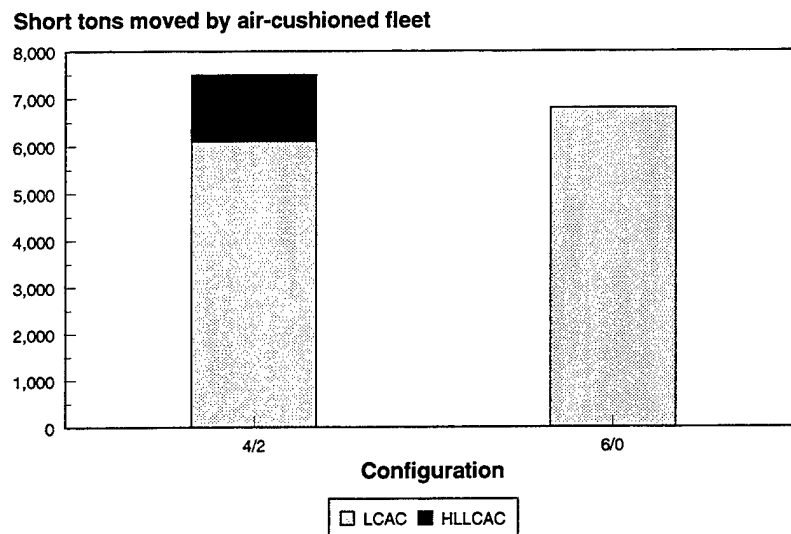
Figure 2-4.
Comparison of Tonnage Carried by 2 HLLCAC/6 LCAC Lighterage Mixtures for Notional Requirement Based on CINC 5

CHAPTER 3

Findings and Conclusions

Our modeling of the HLLCAC, the LCAC, and conventional lighters in MPF and Unified Command LOTS and JLOTS scenarios shows the interaction of the various lighters under different conditions and situations. When the Joint Task Force and JLOTS commanders select lighters to perform an over-the-shore operation, their decisions will be influenced by factors we have addressed. These include the sea state, distance from shore, cargo mix, daily throughput required, and type and number of lighters that are available. Each of these factors will affect productivity at a JLOTS site. The findings and conclusions from our model-based analysis show how the HLLCAC and LCAC could perform in meeting known Service and Unified Command JLOTS requirements.

We find the following:

◆ Without the ACVLAP, the HLLCAC and LCAC are not effective in a LOTS or JLOTS role. Therefore, all subsequent findings and conclusions below assume the availability of at least two ACVLAPs.

◆ With respect to Navy and Marine Corps MPF, adding two HLLCAC and four LCAC to MPF instream unloading can result in a reduction of approximately 36 percent in the time required for discharge operations.

◆ With respect to CINC 4:

▶ The 40- and 80-foot depth lines average 4.8 and 14.5 nautical miles from shore.

▶ If two HLLCAC and four LCAC are available in Phase I (during the first 10 days of CINC 4 JLOTS operations), the initial 2,000-ton daily throughput shortfall identified in the *JLOTS Assessment* report is eliminated.

▶ The addition of two HLLCAC and four LCAC to the CINC 4 lighter pool increases the Phase II excess daily throughput capacity by approximately 78 percent. Phase II begins after the Phase I initial force reception. The excess capacity during Phase II is available for other CINC 4 JLOTS contingency missions.

◆ With respect to CINC 5:

▶ The 40- and 80-foot depth lines average 3.6 and 8.2 nautical miles from shore.

3-1

► In all cases, the LCAC makes a more significant contribution than the HLLCAC in reducing the JLOTS throughput shortfall.

► The daily throughput shortfall can be reduced significantly, but not eliminated when the HLLCAC and LCAC are added to the lighter pool.

► When many wheeled vehicles must be moved via RO/RO operations, the LCAC makes a significant contribution beginning at the one nautical mile mark.

► Beginning at the one nautical mile mark, the LCAC relieves the LCU-1600 and Army LCU-2000 from work on the wheeled vehicle lanes (based on a combination of LCAC speed, loading and discharge time, and the reduced operating hours due to sea state condition).

► At one nautical mile, adding two HLLCAC and four LCAC to the lighter pool reduces the daily throughput shortfall of 8,271 short tons at Site 1 by 2,242 tons, to 6,029 tons or approximately 27 percent (JOTE selected only the four LCAC to support this mission).

► At one nautical mile, substituting two LCAC (for a total of six) for two HLLCAC in the lighter pool reduces the daily throughput shortfall of 8,271 short tons at Site 1 by 2,944 tons, to 5,327 tons or approximately 36 percent.

► At five nautical miles from shore, the LCAC, in RO/RO operations, can out produce all conventional lighters except the Army LSV.

► At the five nautical mile mark, in addition to the LCAC, the HLLCAC begins to be productive; however, the HLLCAC then moves only 3.4 percent of all cargo carried by the air-cushioned lighter assets at this distance.

► At 10 nautical miles from shore, the HLLCAC, in RO/RO operations, begins to out produce all conventional lighters except the LSV; however, even at this distance, the LCAC remains the JOTE model air-cushioned lighter of choice.

► At one nautical mile from shore, with no restrictions, JOTE selected as the optimal lighter mix 1 LSV, 5 LCACs, and 18 CSP+3s, giving a shortfall of 5,145 short tons. In optimizing, JOTE selected the most productive craft for this specific operation without limits on the number or mix of lighters available.

► At 10 nautical miles from shore, the JOTE-optimized solution indicates that with 2 LSVs, 8 LCACs, and 25 CSP+3s, the shortfall remains unchanged at 5,145 short tons.

In conclusion:

- The use of the LCAC in JLOTS operations would make a significant contribution to the total discharge capability, provided the Navy buys the ACVLAP in sufficient quantities (one per RRDF where the LCAC is employed in LOTS or JLOTS operations).

- The LCAC is the better air-cushioned lighter for operations under five nautical miles from shore.

- Because of the additional time required to load and discharge the HLLCAC, it generally provides only marginal improvement over the LCAC in JLOTS operations conducted at ranges of 5 to 10 nautical miles from shore. In fact, depending on the cargo mix, the LCAC can out perform the HLLCAC even in that range.

- The HLLCAC would be most effective when supporting the Amphibious Task Force beyond 10 nautical miles from shore and in over-the-horizon operations.

Regional Infrastructure, Climate, Sea State, and Navigation Data

Table A-1.
Regional Navigation Data

Area	Name	Location	40-foot shelf (nautical miles)	80-Foot Shelf (nautical miles)
Haiti, West Coast	Baie de Miragoane	18°27'N;73°05'W	0.2	1.5
	Baie de Petit Goave	18°26'N;72°53'W	0.1	0.3
	Baie de Port-Au-Prince	18°40'N;72°32'W	0.6	2 .0
	Rade de Foso	18°40'N;72°22'W	0.3	0.6
	Baie de Saint-Marc	19°07'N;72°45'W	0.2	0.4
Panama	Bay of Panama (Pacific)	08°51'N;79°31'W	2.8	7.5
	Limon Bay (Atlantic)	09°21'N;80°01'W	1.0	3.5
	Chagres River (Atlantic)	09°21'N;80°01'W	1.0	2.0
	Las Minas Bay (Atlantic)	09°24'N;79°51'W	1.0	2.5
Croatia	Approaches to Split	43°25'N;16°25'E	0.5	2.0
	Approaches to Ploce	43°01'N;17°25'E	2.0	4.0
Georgia, FSU	Approaches to Batumi	41°39'N'41°40'E	1.0	1.5
	Approaches to Poti	42°10'N;41°36'E	0.8	1.4
South Africa	Table Bay	33°51'S;18°26'E	0.9	2.7
	Simons Bay	34°11S:18°27'E	0.3	2.0
	False Bay	34°12'S;18°40'E	2.0	4.6
Perian Gulf	Approaches to Umm Said	24°53'N;51°38'E	0.9	>20.0
	Approaches to AD Dammam	26°40'N;50°20'E	7.0	12.0
	Approaches to AL Jubayl	27°05'N;49°48'E	4.0	12.0
	Approaches to AL Khafji	28°30'N;48°35'E	3.0	13.0
	Approaches to AZ Zawr	28°50'N:48°23'E	4.0	10.0
	Approaches to Kuwait	29°25'N;48°05'E	10.0	>20.0
Korean Peninsula East Coast	Approaches to Ulsan-Man	35°27'N;129°24'E	0.5	1.5
	Approaches to Pohang	36°04'N;129°28'E	1.0	3.8
	Approaches to Wonson	39°16'N;127°28'E	1.0	4.5 to 6.5
	Approaches to Hungnam	39°45'N;127°40'E	1.0 to 2.0	6.0 to 7.0
West Coast	Approaches to Kunsan	35°58'N;126°16'E	10.0	17.0
	Approaches to Inchon	37°23'N;126°33'E	4.0	6.0
	Approachenes to Chinnampo	38°40'N;124°50'E	3.0 to 4.0	10.0 to 12.0

PORT-AU-PRINCE, HAITI

Latitude 18° 33′ N; Longitude 72° 21′ W

Largest Vessel: 672 feet in length overall; 28.8-foot draft

Approach Depth: Minimum depth at harbor entrance is 49.2 to 78.7 feet

Port Data:

◆ Depth in harbor is 20 to 27.9 feet

◆ Three quays with 20.0- to 27.9-, 18.0- to 21.9-, and 6.9- to 12.0-foot depth alongside

◆ Inner harbor on north side of pier dredged to a depth of 35 feet and can accommodate up to three vessels, including containerships

◆ Finger pier, 799.6 feet long; can accommodate two ships with a draft of 29.9 feet (finger pier is used for cruise ships)

◆ A newly constructed pier can accommodate three containerships; water depth at pierside is 31.8 feet

◆ Open storage is limited within the port

Cranes, MHE, or Special Equipment: One, 30-ton and two mobile cranes at 90-ton and 150-ton capacity; portainer at 30-ton capacity; container pier with two RO/RO platforms are available

Tanker Facilities: Oil company jetties are available

Wind and Weather:

◆ Winds nearly always calm, but from May to November, occasional strong winds may interrupt cargo operations; mornings have light breeze from the NE shifting to the SW and are three times stronger in the afternoon

◆ Mean rise in tide is less than 1 foot

◆ Tidal current = ¼ knot

◆ Average temperatures = in January, over 68°F; in July, over 86°F

◆ Annual rainfall = 40 to 60 inches

Percentage of time the sea state is 2 or less

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
45	47	49	49	50	50	45	50	55	58	48	44

Balboa, Panama (Pacific)

Latitude 80° 57′ N; Longitude 790° 34′ W

Largest Vessel: QE2, 984 feet, 49.2-foot maximum depth

Approach Depth: 4.65-mile channel, 39.3 to 62.3 foot depth, lock chambers 999.7 × 109.9 feet

Port Data:

◆ 4,224-foot wharf and pier space accommodates any vessel that can transit Panama Canal

◆ Open storage is limited within the port area

Cranes, MHE, or Special Equipment: One container crane is available in port; most ships must be self-sustaining; two floating cranes are based outside port complex; port has no roll-on/roll-off (RO/RO) ramp

Tanker Facilities: Two berths; one berth is 849 feet with depth of 33.9 feet and one berth is 700 feet at a 35.9-foot depth

Wind and Weather:

◆ Tidal range = 13 feet

◆ Average temperatures = in January and July, 81°F

◆ Annual rainfall = over 80 inches

Percentage of time the sea state is 2 or less

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
50	50	52	59	54	54	54	55	55	54	54	54

CRISTOBAL, PANAMA (ATLANTIC)

Latitude 9° 21' N; Longitude 79° 55' W

Largest Vessel: FRANCE, 1,101 feet with 39.9-foot maximum depth

Approach Depth: Channel depth is 45 feet

Port Data:

◆ Harbor protected by breakwater providing safe anchorage at depths of 35 to 55.1 feet

◆ 7,570-foot berthing space with water alongside at depths up to 39.9 feet

◆ Open storage is limited within port area, container storage area comprises 246,000 square feet

Cranes, MHE, or Special Equipment: Two, 40-ton gantry cranes at the two container berths; two floating cranes are available (same as used at Balboa, Panama); no special port-owned RO/RO capability

Tanker Facilities: One pier with four berths at 39.9 depth

Wind and Weather:

◆ Northers blow between October and March

◆ Tidal range = less than 1 foot

◆ Average temperatures = in January and July, 81°F

◆ Annual rainfall = over 80 inches

Percentage of time the sea state is 2 or less

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
35	40	45	41	42	42	38	38	47	52	44	38

SPLIT, CROATIA

Latitude 43° 30′ N; Longitude 16° 26′ E

Largest Vessel: Draft is 35 feet for general cargo vessels and 38 feet for tankers

Approach Depth: Two approaches with depths from 32.8 to 49.2 feet

Port Data:

- Anchorage is available 1/2 mile S of breakwater and in well-protected harbor basin

- 8,315 feet of berthing space for up to 15 vessels at 35-foot depth

- Open storage is 492,000 square feet

Cranes, MHE, or Special Equipment: One floating crane at 350-ton capacity, other floating cranes up to 60-ton capacity, general cargo berths have electric cranes with capacity from 5 to 7 tons; no container-handling equipment, limited RO/RO capability; rail access

Tanker Facilities: Two berths at 38-foot draft

Wind and Weather:

- Sometimes violent cold northerly winds (Bora) and hot, dust if winds from the SSW (Sirocco) blow in the approaches but they have little effect within the harbor

- Currents are not appreciable in well protected harbor

- Average temperatures = in January, 32°F to 50°F; in July, over 68°F

- Annual rainfall = 40 to 60 inches

Percentage of time the sea state is 2 or less

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
58	58	55	53	67	69	65	69	58	57	56	48

PLACE (KARDELJEVO), CROATIA

Latitude 43° 03′ N; Longitude 17° 26′ E

Largest Vessel: 722-foot length, 33.9-foot draft

Approach Depth: 1,968-foot-wide channel, 0.5-mile longitude, at 35.9-foot depth

Port Data:

◆ Anchorage available outside harbor entrance

◆ 4,959-foot berthing space available with depths ranging from 21.3 to 34.4 feet — one berthing area has 1,663 feet of pier space at depth of 34.4 feet

◆ Port located in mouth of the navigable Neretva River

◆ Open storage is 984,000 square feet

Cranes, MHE, or Special Equipment: One 100-ton floating crane; one mobile crane at 50-ton capacity and three at 25 tons; 15 shore cranes; and one container forklift at 35-ton capacity provides shore support for self-sustaining containerships, RO/RO ramp; rail and inland waterway access

Tanker Facilities: One berth, 30-foot maximum depth

Wind and Weather:

◆ Port is well sheltered, but strong SE and NE winds may cause hazards at two of the 11 berths

◆ Channel may at times be hazardous due to cross current from Neretva River

◆ Tidal current = 3 knots or less

◆ Average temperatures = in January, 32°F to 50°F, in July, over 68°F

◆ Annual rainfall = 40 to 60 inches

Percentage of time the sea state is 2 or less

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
52	53	54	52	65	68	65	68	57	57	55	47

BATUMI (BATUMSKAYA BUKHTA) GEORGIA

Latitude 41° 39′ N; Longitude 40° 39′ E

Largest Vessel: 69,992 dwt, 796-foot length, 42.6-foot depth

Approach Depth: Head of Batumi Bay

Port Data:

- Anchorage depths of 49.2 to 65.6 feet, anchorage in the inner roads is possible

- 12 berths with 4,067 feet along two moles protecting harbor from N and E winds, depth 26.2 to 42.6 feet

- Passenger pier accommodates four ocean-going liners

- Shallow coastal harbor pier

- Some concrete surfaced open storage

Cranes, MHE, or Special Equipment: One, 100-ton floating crane, several floating cranes up to 30-ton capacity; mobile electric cranes up to 20 tons; no special RO/RO or container capability; rail access

Tanker Facilities: One buoy berth for 44,000 dwt tankers; three mole berths for tankers with maximum draft of 31.1 feet

Wind and Weather:

- Winds from SW, W, and NW cause strong variable current with surge within the port — not frequent, but will occur October to May causing some ships to move to sea or anchorage

- Average temperatures = in January, 14°F to 32°F; in July, over 68°F

- Annual rainfall = 10 to 20 inches

Percentage of time the sea state is 2 or less

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
62	59	62	67	67	67	62	62	59	66	62	60

POTI, GEORGIA

Latitude 42° 09′ N; Longitude 41° 39′ E

Largest Vessel: 68,499 dwt, 738-foot length

Approach Depth: Open road, Rioni River is 1.9 miles South of harbor

Port Data:

♦ Two anchorage areas in outer roads with depth from 32.8 to 98.4 feet

♦ Port protected by breakwater and moles divided into three harbor areas

♦ 17 berths (2 container) with 15,000 feet and up to 41 feet alongside

♦ Passenger terminal with 6,448 feet of berthing space

♦ Some concrete-surfaced open storage

Cranes, MHE, or Special Equipment: One floating crane at 100-ton capacity; several mobile electric portal cranes up to 16 tons; no specifically designated RO/RO berth; Rioni River inland waterway and rail access

Tanker Facilities: Available

Wind and Weather:

♦ Severe conditions from the W and NW can make the harbor inaccessible

♦ Average temperatures = in January, 14°F to 32°F; in July, over 68°F

♦ Annual rainfall = 10 to 20 inches

Percentage of time the sea state is 2 or less

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
62	59	62	67	67	67	62	62	59	66	62	60

Cape Town, South Africa

Latitude 33° 54′ S; Longitude 18° 26′ E

Largest Vessel: 250,000 dwt, maximum 42.9-foot depth in harbor

Approach Depth: Victoria Basin is 37.9 feet, Duncan Dock is 41.9 feet, and Ben Schoeman Dock is 45.1 feet

Port Data:

◆ Anchorage is available in bay protected by 5,140-foot breakwater

◆ Victoria Basin has available 4,823 feet of berthing space — largest berth is 697 feet with alongside depth of 32 feet, the smallest is 59 feet with a depth of 9.7 feet

◆ Duncan Dock has available 8,429 feet of berthing space — largest berth is 1,044 feet with 39.2-foot depth alongside; the smallest is 144 feet longitude at 19.9-foot depth: there are 7 berths greater than 787 feet in length with a pierside depth of 33.3 to 39.2 feet depth

◆ Duncan Dock Repair Pier, NE side berth, is 1,459 feet longitude with 39.2-foot depth, SW berth is 1,397 feet with 39.2-foot depth

◆ Ben Shoeman Basin has available 7,662 feet of berthing space — largest berths — 3 are 1,000 feet longitude with 45.8 feet alongside (harbor basin approach depth is 45.1 feet), smallest is 600 feet at 35-foot depth

◆ Port has five berths for ships of 1,000-foot length and 39-foot draft

◆ Open storage is unlimited next to covered sheds; 3,181,600 square foot available in container area

Cranes, MHE, and Special Equipment: One floating crane at 200 tons; 7 shore cranes at 15 tons, 103 at 4 tons, and 5 container berths with gantry cranes and 6 berths RO/RO capable; rail access

Tanker Facilities: Two berths from 669 to 839 feet in length at depth of 42.9 feet

Wind and Weather:

◆ Winds from the SE from October through April; NW from May through September; high winds over 60 knots and lasting several hours have occurred in the harbor during summer

◆ Mean rise of spring tide is 5.2 feet, neap tide is 1.9 feet

◆ No apparent tidal current; harbor current is usually 1/2 knot or less, but as high as 3 knots in summer

◆ Average temperature = in January and July, 50°F to 68°F

◆ Annual rainfall = 20 to 40 inches

Percentage of time the sea state is 2 or less

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
25	28	27	31	33	30	28	26	25	25	25	20

UMM SAID, QATER

Latitude 24° 54′ N; Longitude 51° 34′ E

Largest Vessel: Draft of 42.6 feet

Approach Depth: 7,424-foot wide approaches dredged to 41.0 and 42.6 feet

Port Data:

◆ Major petrochemical port

◆ Two wharf areas used for petrochemicals — total available pier space 4,060 feet with depth of 42.6 feet

◆ Three general cargo berths total 1,870 feet in length with 42.6 feet alongside

◆ Protected small-craft harbor at 14.7-foot depth

◆ Open storage is 590,000 square feet

Cranes , MHE, or Special Equipment: Port is currently not equipped with cargo-handling gear for container or RO/RO operations

Tanker Facilities: Crude oil loading facility with offshore buoy mooring at 64.2-foot depth

Wind and Weather:

◆ Usually only one high and one low water in a 24-hour period; tidal range is 4.2 feet but can vary on exception 8 feet

◆ Average temperatures = in January, 50°F to 68°F; in July, over 86°F

◆ Annual rainfall = under 10 inches

Percentage of time the sea state is 2 or less

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
57	54	59	65	60	58	62	69	69	68	57	69

DOHA, QATAR

Latitude 27° 17′ N; Longitude 51° 32′ E

Largest Vessel: 600 feet by 80-foot beam and 28.5-foot depth

Approach Depth: 350-foot-wide channel for ships with maximum draft of 28.7 feet

Port Data:

◆ Deep water quay of 4 berths is 2,438 feet longitude with 29.9 feet alongside

◆ A second quay with 5 berths is 3,135 feet in length with a depth of 24.6 feet

◆ Open storage is 887,565 square feet

Cranes, MHE, or Special Equipment: Ships gear or mobile cranes with 3 to 70-ton capacity, two straddle cranes and two container forklifts at 35-ton capacity

Tanker Facilities: None

Wind and Weather:

◆ Tidal range = spring is 4.9 feet, neap is 3.9 feet

◆ Tidal current = 1½ knots

◆ Average temperatures = in January, 50°F to 68°F; in July, over 86°F

◆ Annual rainfall = less than 10 inches

Percentage of time the sea state is 2 or less

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
53	52	53	62	59	57	62	71	71	67	57	58

AD DAMMAM, SAUDIA ARABIA

Latitude 26° 30′ N; Longitude 50° 12′ E

Largest Vessel: Draft of 45.9 feet

Approach Depth: Channel is 820 feet wide dredged to 49.2-foot minimum depth

Port Data:

◆ Three anchorages with depths of 49.2, 32.8, and 26.2 feet

◆ 21,169 feet of pier space with 39 berths; largest 787 feet longitude with 45.9-foot depth, smallest is 587 feet with 29.5 feet alongside; combining adjacent pier space creates 8 berths over 950 feet longitude with 45.9 feet alongside

◆ Small craft quay of 5,248 feet with 14.7- to 19.6-foot depth

◆ Open storage is 9,656,320 square feet

Cranes, MHE, or Special Equipment: 47 portal cranes at 6- to 15-ton capacity; six, 40-ton container cranes; 138 mobile cranes at 15 to 90 tons; one, 200-ton floating crane; and four RO/RO and four container berths; rail access

Tanker Facilities: None

Wind and Weather:

◆ Strong NW winds occur during Shamal season — lighters cannot work during Shamal; highest swells occur with S winds

◆ Mean tidal range is 4.2 feet, 7.8-foot spring and 2.6-foot neap

◆ Tidal current at main wharf is 4 knots with highest reported at 6 knots

◆ Average temperatures = in January, 50°F to 68°F; in July, over 86°F

◆ Annual rainfall = less than 10 inches

Percentage of time the sea state is 2 or less

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
55	52	55	64	60	56	62	74	69	67	57	69

AL JUBAYL, SAUDIA ARABIA

Latitude 27° 05' N; Longitude 49° 40' E

Largest Vessel: 311,883 dwt, 1,127-foot length overall

Approach Depth: Two entrances dredged to 45.9 feet

Port Data:

♦ Approximately 18,696 feet of berthing space with depth alongside between 39.3 and 45.9 feet

♦ Two berths, each of 984 feet with 45.9 feet alongside; and four berths, each 820 feet long, at 45.9 feet — can accommodate four large vessels exceeding 950 feet.

♦ Eight berths, each 695 feet long at depth of 45.9 feet, are also available, combining some berths gives additional pier space for large vessels

♦ Three coaster berths at 19.6-foot depth

♦ Open storage is 3,125,840 square feet

Cranes, MHE, or Special Equipment: Four gantry cranes at 30-ton capacity, nine transtainers at 30-ton capacity, mobile cranes from 20- to 100-ton capacity and one RO/RO ramp and two combination RO/RO container berths

Tanker Facilities: Four sea berths for up to 500,000 dwt at 98.4-foot depth

Wind and Weather:

♦ Prevailing wind from the NW and not predictable for more than a few hours

♦ Tidal range = 6.5 feet

♦ Tidal current less than one knot

♦ Average temperatures = in January, 50°F to 68°F; in July, over 86°F

♦ Annual rainfall = under 10 inches

Percentage of time the sea state is 2 or less

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
55	52	55	64	60	56	62	74	69	67	57	69

ASH SHUWAYKH, KUWAIT

Latitude 20° 21′ N; Longitude 47° 56′ E

Largest Vessel: 44,000 dwt, maximum draft of 31.4 feet with maximum length overall of 853 feet

Approach Depth: 4.46-mile channel, 500 feet wide, dredged to 27.9 feet

Port Data:

- Four anchorage areas with depths from 31 to 68.8 feet (7 anchorage berths at depths of 43.9 feet)

- 18 deep-water berths with 32.9 feet alongside berths between 587 and 692 feet in length

- 5,655 feet of berthing space for ships drawing below 27.9 feet

- Small-craft basin has 2,358 feet of berthing space at 10.9-foot depth

- Open storage is 1,249,680 square feet

Cranes, MHE, or Special Equipment: 14 cranes at 6-ton capacity, 45 cranes at 3 tons each, various mobile cranes with 15- to 250-ton capacity, 100-ton floating crane, two 35-ton gantry cranes, one RO/RO, and two container berths

Tanker Facilities: None

Wind and Weather:

- Prevailing winds from NW; winds from NW or SE can create a heavy swell in harbor

- Mean tidal rise = 11.1 feet

- Tidal current = 2 to 3 knots at spring tide

- Average temperatures = in January, 50°F to 68°F, in July, over 86°F

- Annual rainfall = under 10 inches

Percentage of time the sea state is 2 or less

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
59	54	60	65	66	61	63	65	80	65	50	61

ULSAN-MAN, ROK (I.E., SOUTH KOREA)

Latitude 35° 29′ N; Longitude 129° 24′ E

Largest Vessel: 45,000 dwt, 705 feet in length, 36-foot draft

Approach Depth: Channel is 2.3 miles long, 656 feet wide, and 39.3 feet deep

Port Data:

◆ Outer harbor has 14 anchorages with depths from 19.6 to 49.2 feet

◆ 3,287 feet of pier space at depths from 27.8 to 36 feet of which 656 feet is at a depth of 36 feet and 853 feet is at 34.4 feet (combined it is 1,509 feet with 34.4 feet alongside)

◆ 1,771-foot lighter wharf at depth of 16.4 feet

◆ Open storage is 209,920 square feet

Cranes, MHE, or Special Equipment: One shore crane at 300-ton capacity, 10 mobile cranes from 20- to 80-ton capacity, no special container or RO/RO capability; rail access

Tanker Facilities: Pier and buoy berths with alongside depth from 22.9 to 70 feet — largest tanker 250,000 dwt

Wind and Weather:

◆ Winds from S send heavy sea into inlet; heavy fog frequent in June and July

◆ Tidal range spring is 1.7 feet, neap is 1.2 feet

◆ Tidal current = 1¼ to 2 knots

◆ Average temperatures = in January, 32°F to 50°F; in July, 68°F to 86°F

◆ Annual rainfall = 60 to 80 inches

Percentage of time the sea state is 2 or less

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
41	39	46	50	52	56	50	55	63	50	45	50

POHANG, ROK

Latitude 36° 01' N; Longitude 129° 25' E

Largest Vessel: 150,000 dwt; 984-foot length, 47.5-foot depth

Approach Depth: Open roadstead 3.5 miles wide at depth of 78 feet

Port Data:

♦ Anchorage available in inner harbor at depths from 20 to 62.9 feet

♦ 7,806 feet of bulk and general cargo pier space with 32.8 to 47.5 feet alongside — two bulk cargo piers: Pier 1 is 3,116 feet with alongside depth of 47.5 feet, and Pier 2, at 3,313 feet, has a depth of 36 feet

♦ Open storage is 779,525 square feet

Cranes, MHE, or Special Equipment: Four cranes at 15-ton, three at 25-ton, three at 30-ton, and one at 35-ton shore cranes; mobile cranes 7- to 150-ton capacity; no special accommodation for container or RO/RO cargo

Tanker Facilities: Two bouy berths connecting to military pipleline

Wind and Weather:

♦ NE winds from November through April can cause heavy swells making navigation difficult for small craft in the harbor

♦ Tidal range = less than 1 foot

♦ Average temperatures = in January, 14°F to 32°F; in July, 68°F to 86°F

♦ Annual rainfall = 40 to 60 inches

Percentage of time the sea state is 2 or less

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
37	40	43	50	57	50	57	57	57	50	43	37

WONSON, DPRK (I.E., NORTH KOREA)

Latitude 39° 10'N; Longitude 127° 26' E

Largest Vessel: Maximum depth at wharf is 25.9 feet; at anchorage, it is up to 60.6 feet

Approach Depth: Depths at outer entrance from 36.0 to 60.6 feet decreasing to between 21.9 and 26.8 feet in the entrance and middle harbor

Port Data:

◆ Anchorage outside the breakwaters offers depths of 22.9 to 42.6 feet

◆ One wharf is 900 feet long with 20.0 to 25.9 feet alongside available

◆ Other piers for smaller vessels and lighterage

◆ Large ocean-going vessels are discharged at anchorage using lighters

Cranes, MHE, or Special Equipment: Limited cargo-handling equipment is available; no container or RO/RO facilities; rail accesss

Tanker Facilities: An oil pier is available, but minimum depths alongside in inner harbor restrict size

Wind and Weather:

◆ Persistent strong W winds prevail; very cold in January and February; drift ice present, but harbor not ice bound

◆ Low-lying fog on average of 10 days a year

◆ Average temperatures = in January, 14°F to 32°F; in July, 68°F to 86°F

◆ Annual rainfall = 40 to 60 inches

Percentage of time the sea state is 2 or less

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
50	43	57	64	60	59	52	47	47	47	53	52

Hungnam, DPRK

Latitude 39° 48′ N; Longitude 127° 40′ E

Largest Vessel: In-stream discharge

Approach Depth: Deep and clear of dangers; middle of the bay is 36.0- to 48.2-foot depth

Port Data:

♦ Anchorage is 1¼ miles S of breakwater light at 35.7- to 41.9-foot depth

♦ Depth of harbor is 21.9 to 25.9 feet

♦ Large vessels use in-stream discharge with lighters

Cranes, MHE, or Special Equipment: Cranes, including gantry, available up to 40-ton capacity; no container or RO/RO facilities; rail access

Tanker Terminal: Port does not handle pertroleum products

Wind and Weather:

♦ NW gales can raise considerable sea in winter and spring; in summer, winds from the S sometimes bring a heavy sea — thin ice, not hazardous to navigation, may occur in January and February

♦ Average temperatures = in January, 14°F to 32°F; in July, 68° to 86°F

♦ Annual rainfall = 40 to 60 inches

Percentage of time the sea state is 2 or less

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
50	42	57	65	62	59	52	48	48	48	54	52

Kunsan, ROK

Latitude 36° 00′ N; Longitude 126° 43′ E

Largest Vessel: 738-foot length, 22.1-foot draft

Approach Depth: Narrow approach with many hazards to navigate

Port Data:

◆ Anchorage outside harbor required for large ocean going vessels

◆ Two piers are 3,362 feet in length with depths of 26.2 to 36.0 feet alongside — largest is 1,995 feet long with depth of 36 feet

◆ Three causeway pontoons, 380 to 600 feet long with depths ranging from 22.9 to 28.8 feet

◆ Limited open storage is available

Cranes, MHE, or Special Equipment: 12 mobile cranes at 10- to 80-ton capacity, one gantry crane at 35 tons; no RO/RO-prepared berths

Tanker Facilities: Available for smaller shallow-draft vessels

Wind and Weather:

◆ Winds are usually light; gales are rare — an average of about 30 days per year when instream cargo operations are interrupted at river mouth and 10 days pierside

◆ Tidal range = 12.9 to 23.7 feet

◆ Tidal current = 1.5 to 3.0 knots

◆ Average temperatures = in January, 14°F to 32°F; in July, 68°F to 86°F

◆ Annual rainfall = 40 to 60 inches

Percentage of time the sea state is 2 or less

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
45	42	49	56	58	60	50	51	50	52	48	46

INCHON, ROK

Latitude 37° 28′ N; Longitude 126° 36′ E

Largest Vessel: 50,000 dwt, 990-foot length at 42.6-foot depth

Approach Depth: Winding and narrow passage at 42.6 feet depth

Port Data:

◆ Anchorage available in outer harbor at depths up to 59 feet

◆ Inner harbor is controlled by locks allowing ships up to 50,000 dwt

◆ 16,626 feet of general cargo and container berths from 24.6 to 42.6 feet in depth; container berth is 3,804 feet long with a depth of 39.3 feet

◆ 2,329 feet of lighterage wharf

◆ Open storage is 393,600 square feet

Cranes, MHE, or Special Equipment: Three floating cranes at 27- to 110-ton capacity; four gantry cranes at 5 to 35 tons, 100 mobile cranes at 10 to 225 tons, four fixed cranes at 28 to 35 tons, three transtainers at 30 tons; 8 container berths and 1 RO/RO ramp

Tanker Facilities: One pier and two anchorage facilities for 50,000 dwt ships

Wind and Weather:

◆ Rainy season in early summer; typhoons occur once or twice a year; morning fog in June and July

◆ Tidal range = 30 feet; vessels outside basin anchor from 3 to 5 miles offshore

◆ Tidal current in inner harbor approximately 1 knot

◆ Average temperatures = in January, 14°F to 32°F; in July, 68°F to 86°F

◆ Annual rainfall = 40 to 60 inches

Percentage of time the sea state is 2 or less

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
48	43	59	62	62	60	50	48	48	48	50	48

CHINNAMPO, DPRK

Latitude 38° 44′ N; Longitude 127° 25′ E

Largest Vessel: Vessels drawing more than 32.8 feet normally discharged in the stream

Approach Depth: River channel is up to 88.5-foot depth

Port Data:

◆ Up to 15 ocean-going vessels can anchor in the river at depths of from 42.6 to 88.5 feet — most larger ships are discharged in stream using lighters

◆ Port has nearly 1.2 miles of berthing space at depths from 19.6 to 32.8 feet

◆ Nampo may now possess deep-water berths and container cranes and other improved cargo-handling gear

Cranes, MHE, or Special Equipment: One, 150-ton floating crane and a number of cranes up to 5-ton capacity; no specified container or RO/RO facilities; rail access

Tanker Facilities: Port does not handle petroleum products other than bunkers

Wind and Weather:

◆ Ice conditions occur during January and February; three weeks of the year port is cut off from the sea because of drift ice

◆ Heavy fog during July and August

◆ Tidal current = runs at 2 to 3 knots

◆ Average temperatures = in January, 14°F to 32°F; in July, 68° to 86°F

◆ Annual rainfall = 20 to 40 inches

Percentage of time the sea state is 2 or less

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
49	46	53	59	61	65	50	49	48	48	52	49

Air Cushioned Vehicle Landing Platform Technical Demonstration

Table B-1.

Air Cushion Vehicle Landing Platform (ACVLAP) Technology Demonstration (20 – 21 June 1994)

Flight number	LCAC number	LCAC load type	Approach speed (knots)	Aproach approach	LCAC bow at ACVLAP	Approach time	On hover	Positioining time	Off-cushion moor	Setting time
21 June 1994										
1	39	Empty		11:04:40			11:05:55		11:06:10	00:00:15
2	37	Empty		11:20:50	11:21:40	00:00:50	11:22:12	00:00:32	11:22:35	00:00:23
3	39	Empty		11:25:33	11:26:05	00:00:32	11:26:25	00:00:20		
4	37	Empty		11:29:00	11:29:31	00:00:31	11:30:00	00:00:29	11:30:15	00:00:15
5	39	M1A1 tank			13:00:27		13:01:46	00:01:19		
6	37	4 Vehicles			13:07:38		13:08:00	00:00:22		
7	39	M1A1 tank					13:14:32		13:14:57	00:00:25
8	37	4 Vehicles		14:03:00	14:03:27	00:00:27	14:04:00	00:00:33		
9	39	Empty			14:12:21		14:12:38	00:00:17	14:13:35	00:00:57
10	37	4 Vehicles		14:53:11	14:53:36	00:00:25	14:53:59	00:00:23	14:55:03	00:01:04
22 June 1994										
11	38	Empty			10:14:26		10:14:58	00:00:32	10:15:50	00:00:52
12	39	M1A1 tank		10:28:00	10:28:40	00:00:40	10:28:59	00:00:19	10:29:50	00:00:51
13	38	Empty	6	10:38:30	10:38:58	00:00:28	10:39:29	00:00:31		
14	39	M1A1 tank	6	10:40:55	10:41:12	00:00:17	10:41:30	00:00:18		
15	38	Empty	7		10:44:08		10:44:35	00:00:27	10:44:55	00:00:20
16	39	M1A1 tank	8		10:51:34		10:52:00	00:00:26		
17	38	Empty	8				11:00:00			
18	39	M1A1 tank	8		11:37:56		11:38:14	00:00:18		
19	38	RTCH	8	11:42:30	11:43:08	00:00:38	11:43:36	00:00:28	11:44:00	00:00:24
20	39	M1A1 tank	7		11:47:55		11:48:17	00:00:22	11:48:30	00:00:13
21	38	RTCH	8							
22	39	M1A1 tank	8							
23	38	RTCH	7		11:57:04		11:57:29	00:00:25		
24	39	M1A1 tank	7	12:01:36	12:01:58	00:00:22	12:02:16	00:00:18		
25	38	RTCH	7	12:04:50	12:05:20	00:00:30	12:05:40	00:00:20	12:06:09	00:00:29
26	39	M1A1 tank	7	12:29:00	12:29:31	00:00:31				
Night operations										
27	38	Empty		20:26:35	20:27:20	00:00:45	20:27:32	00:00:12	20:27:43	00:00:11
28	38	Empty		20:32:15	20:32:42	00:00:27	20:32:54	00:00:12	20:33:12	00:00:18
29	39	M1A1 tank	7	20:42:12	20:42:47	00:00:35	20:43:04	00:00:17	20:43:46	00:00:42
30	38	Empty		21:08:50	21:09:34	00:00:44	21:09:54	00:00:20	21:10:10	00:00:16
31	39	Empty								
32	38	M1A1 tank	7							
33	39	RTCH&CONT								
34	38	M1A1 tank	8							
35	39	RTCH&CONT								
Draft data analysis as of 21 April 1995					Average	00:00:33		00:00:25		00:00:30
					Count	16		24		16
					Minimum	00:00:17		00:00:12		00:00:11
					Maximum	00:00:50		00:01:19		00:01:04

-cushion moor	Setting time	Approach and minor	Activity	LCAC load type	On-cushion castoff	Off	Away clear	Castoff and clear
1:06:10	00:00:15	00:01:30	Discharge personnel	Empty	11:18:15	11:18:55	11:19:20	00:01:05
1:22:35	00:00:23	00:01:45	Discharge personnel	Empty	11:24:00	11:24:45		
			Hover and go	Empty	11:27:25	11:28:05	11:28:25	00:01:00
1:30:15	00:00:15	00:01:15	Land and go	Empty	11:35:21	11:35:55	11:36:30	00:01:09
			Hover and go	M1A1 tank	13:03:35	13:04:10		
			Hover and go	4 Vehicles	13:09:58	13:10:34		
3:14:57	00:00:25		Discharge	Empty	13:58:01	13:58:27	13:59:00	00:00:59
			Hover and go	4 Vehicles	14:05:18	14:06:00		
4:13:35	00:00:57		Loading	M1A1 tank	14:47:59	14:48:31	14:48:55	00:00:56
4:55:03	00:01:04	00:01:52	Attempting to discharge	4 Vehicles	15:33:33			
0:15:50	00:00:52		Discharge personnel	Empty	10:24:54	10:25:35	10:26:20	00:01:26
0:29:50	00:00:51	00:01:50	Equipment delay	M1A1 tank	10:36:35	10:37:00	10:37:25	00:00:50
			Hover and go	Empty	10:39:34	10:40:05	10:40:30	00:00:56
			Hover and go	M1A1 tank	10:41:37	10:42:04	10:42:30	00:00:53
0:44:55	00:00:20		Land and go	Empty				
			Hover and go	M1A1 tank	10:52:06	10:52:36	10:53:00	00:00:54
			Loading	RTCH	11:35:08	11:36:10	11:36:48	00:01:40
			Hover and go	M1A1 tank	11:39:16	11:39:52	11:40:20	00:01:04
:44:00	00:00:24	00:01:30	Land and go	RTCH	11:46:01			
:48:30	00:00:13		Hover and go	M1A1 tank	11:48:30	11:48:50	11:49:20	00:00:50
			Hover and go	RTCH				
			Hover and go	M1A1 tank			11:55:48	
			Hover and go	RTCH		12:00:31	12:00:50	
			Hover and go	M1A1 tank	12:02:27	12:02:47		
:06:09	00:00:29	00:01:19	Discharge	Empty	12:26:00	12:26:18	12:27:00	00:01:00
			Discharge and load	M1A1 tank	13:14:57	13:15:28		
:27:43	00:00:11	00:01:08	Discharge personnel	Empty		20:29:00		
:33:12	00:00:18	00:00:57	Land and go	Empty			20:38:10	
:43:46	00:00:42	00:01:34	Discharging	Empty			21:01:10	
:10:10	00:00:16	00:01:20	Loading	M1A1 tank	21:55:00	21:55:45	21:56:15	00:01:15
			Loading	RTCH&CON				
			Hover and go	M1A1 tank				00:01:05
			Hover and go	RTCH&CON				
			Discharge personnel	M1A1 tank				
			Discharge	Empty			22:50:52	
	00:00:30	00:01:27						00:01:04
	16	11						16
	00:00:11	00:00:57						00:00:50
	00:01:04	00:01:52						00:01:40

Lighter Descriptions and Joint Logistics Over the Shore Diagrams

Landing Craft, Air Cushioned (LCAC) – Navy

Inventory objective: 91
Number on hand: 89 (includes production)
Cost: $17 million (1994)

Mission: To transport cargo from ship to shore in amphibious operations
Transportability: Navy amphibious ships and commercial barge ships
Cruising range: 110 nautical miles (one round trip in SS2) with a payload of 85 short tons
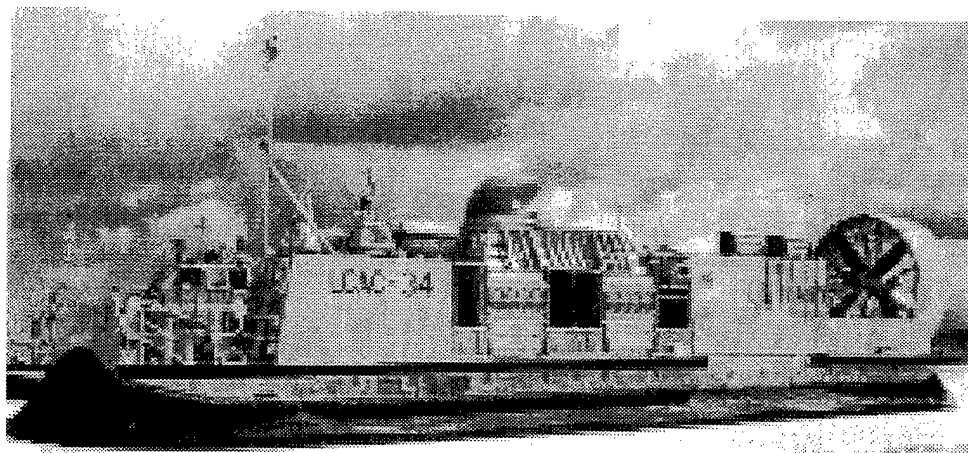**Length, overall:** 87 feet, 11 inches
Beam: 47 feet
Speed: 40 knots fully loaded
Cargo capacity: Rated at 60 short tons; however, on a "standard day" (SS2 with temperature between 60°F and 80°F), the LCAC can carry 75 tons
Crew: 5

Representative loads: 1 M1A1 tank and 3 HMMWV, or
4 trucks and 3 HMMWV, or
2 AAV and 4 HMMWV, or
2 LVS and 4 HMMWV, or
9 HMMWV

Logistics Support Vessel (LSV) – Army

Inventory objective: 6
Number on hand: 6
Cost: $16 million (1995)

Mission: To transport cargo in ocean, coastal, and inland waterways
Transportability: Self-delivery
Cruising range: 8,200 nautical miles empty; 5,500 nautical miles loaded
Length, overall: 272.75 feet
Beam: 60 feet
Draft (max): 12 feet
Speed: 11.5 knots loaded
Cargo capacity: 2,000 short tons with 10,500 square feet of deck space
Crew: 31

Representative loads: 24 M1A1 tanks, or
50 wheeled vehicles, or
50 twenty-foot containers (double stacked)
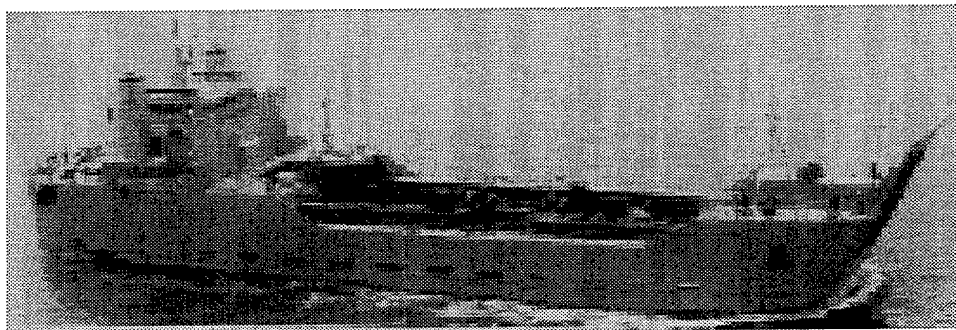
LANDING CRAFT, UTILITY (LCU-2000) – ARMY

Inventory objective: 51
Number on hand: 35
Cost: $4 million (1995)

Mission: To transport cargo from ship offshore to shore and in areas that cannot be reached by ocean-going vessels. Vessel can operate on coastal waters and on the open ocean.
Transportability: Self-delivery; however, preferred method is heavy lift or float-on/float-off ship
Cruising range: 4,500 nautical miles
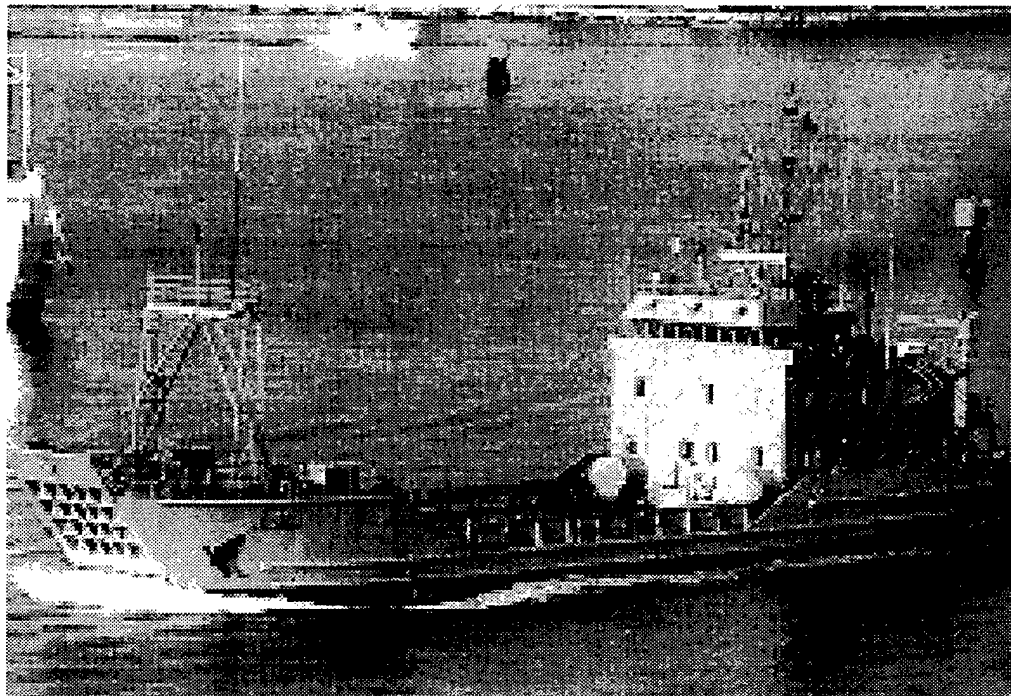**Length, overall:** 175 feet
Beam: 42 feet
Draft, loaded: 4 feet forward, 9 feet aft
Speed: 11 knots fully loaded
Cargo capacity: 350 short tons with 2,500 square feet of deck space
Crew: 13

Representative loads: 5 M1A1 tanks, or
13 wheeled vehicles, or
28 twenty-foot containers (double stacked)

LANDING CRAFT, UTILITY (LCU-1600 CLASS) – NAVY AND ARMY

Inventory objective: Navy – 41; Army – 13
Number on hand: 54
Cost: $3 million (1986)

Mission: To transport cargo, troops, and vehicles from ship to shore, shore to shore, or in retrograde movements; may be used for lighterage and utility work in harbors and inland waterways
Transportability: Amphibious ships, deck loaded on commercial ships, heavy lift, SEABEE, or float-on/float-off ships
Cruising range: 1,200 nautical miles empty or loaded
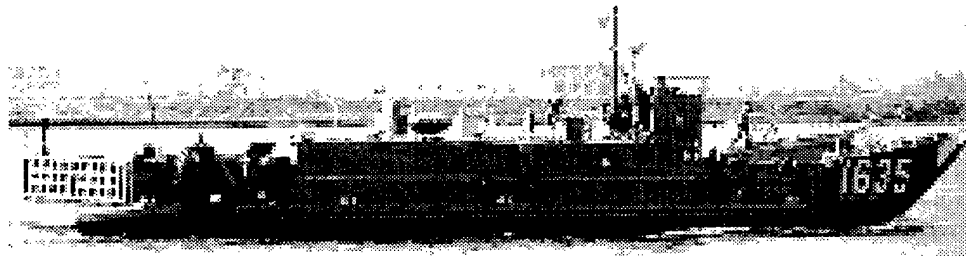**Length, overall:** 135 feet
Beam: 29 feet
Draft, loaded: 3 feet, 2 inches forward; 6 feet, 5 inches aft
Speed: 11 knots fully loaded
Cargo capacity: 187 short tons with 1,800 square feet of deck space
Crew: 13/14

Representative loads: 2 M1A1 tanks, or
4 wheeled vehicles, or
8 twenty-foot containers (double stacked)

Landing Craft, Mechanized (LCM-8) – Navy and Army

Inventory objective: Navy-60; Army-114
Number on hand: 174
Cost: $600,000 (1986)

Mission: To transport cargo, troops, and vehicles from ship to shore, shore to shore, or in retrograde movements. May be used as lighter in harbor and inland waterways.
Transportability: Deck loaded on any commercial cargo ship, SEABEE, or float-on/float-off ship
Cruising range: 271 nautical miles loaded
Length, overall: 73 or 74 feet
Beam: 21 feet
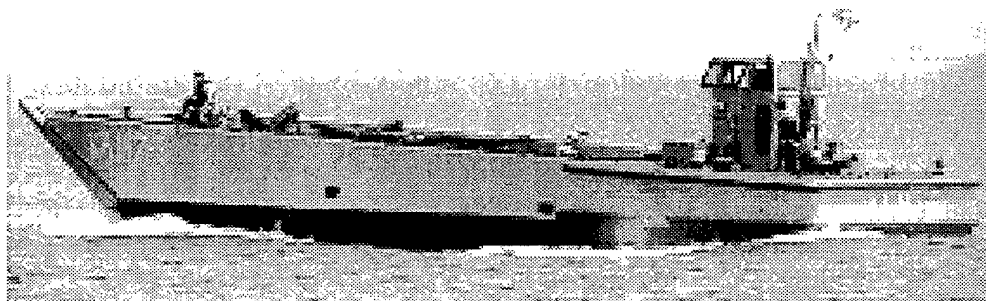**Draft, loaded:** mean 4 feet, 7 inches
Speed: 12 knots loaded
Cargo capacity: 65 short tons with 620 square feet of deck space
Crew: 5

Representative loads: 1 light-tracked vehicle (M60 tank and under)
1 wheeled vehicle (tractor/trailer)
1 twenty-foot container

CAUSEWAY FERRY OR CAUSEWAY SYSTEM, POWERED (CSP) – NAVY AND ARMY

Inventory objective: Navy-64 CSP+2s (Navy can build CSP+3 systems by adding an additional 90-foot section); Navy-13 CSPs+1s; Army-8 CSP+3s

Number on hand: Navy-64 CSP+2s; Navy-13 CSP+1s; Army-1 CSP+3

Cost: Navy will spend, on average, $2.5 million annually for replacement non powered causeway sections. Army will spend $1.75 million per CSP+3s

Mission: To provide a rapid means of transporting rolling stock and containers/breakbulk cargo from ship to shore in LOTS or JLOTS operations

Transportability: All Navy and commercial cargo ships and LSTs

Length overall and beam: Dependent on the number of sections brought together to build a causeway ferry:
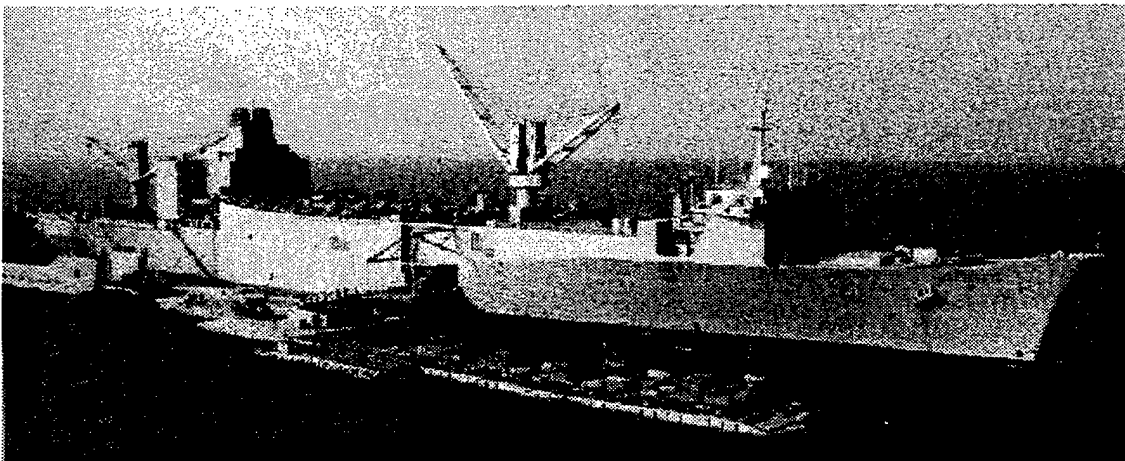- ► Navy causeway sections are 90 feet long, 21 feet wide with a 90-ton capacity; and
- ► Army modular causeway sections are 12 feet wide and 40 feet long with a capacity of 70 tons (when two sections are linked in parallel)

Speed: 5 knots loaded

Cargo capacity: 350 short tons (CSP+3)

Crew: 5

Representative loads: 3 M1A1 tanks, or
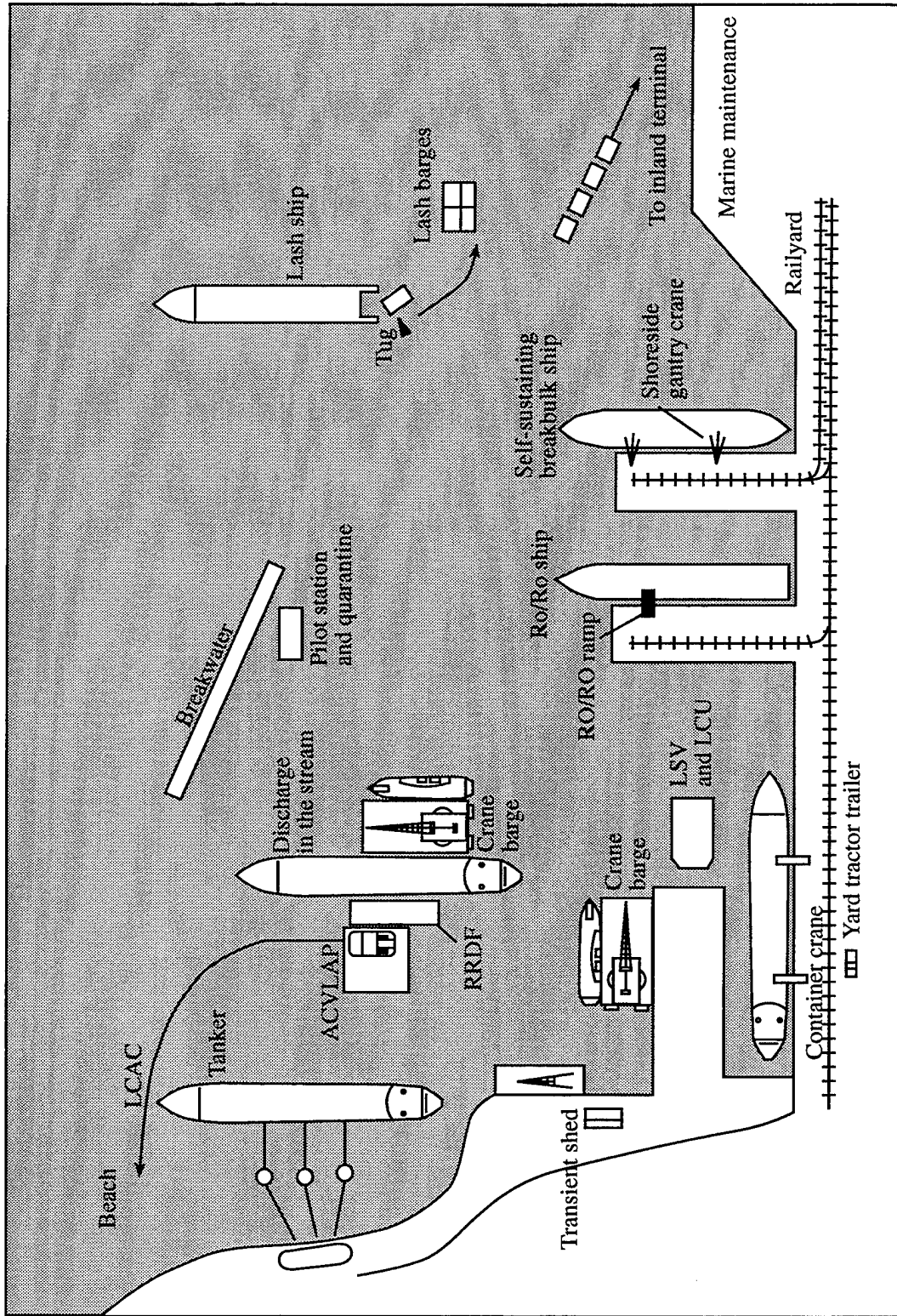16 wheeled vehicles, or
24 twenty-foot containers

Figure C-1.
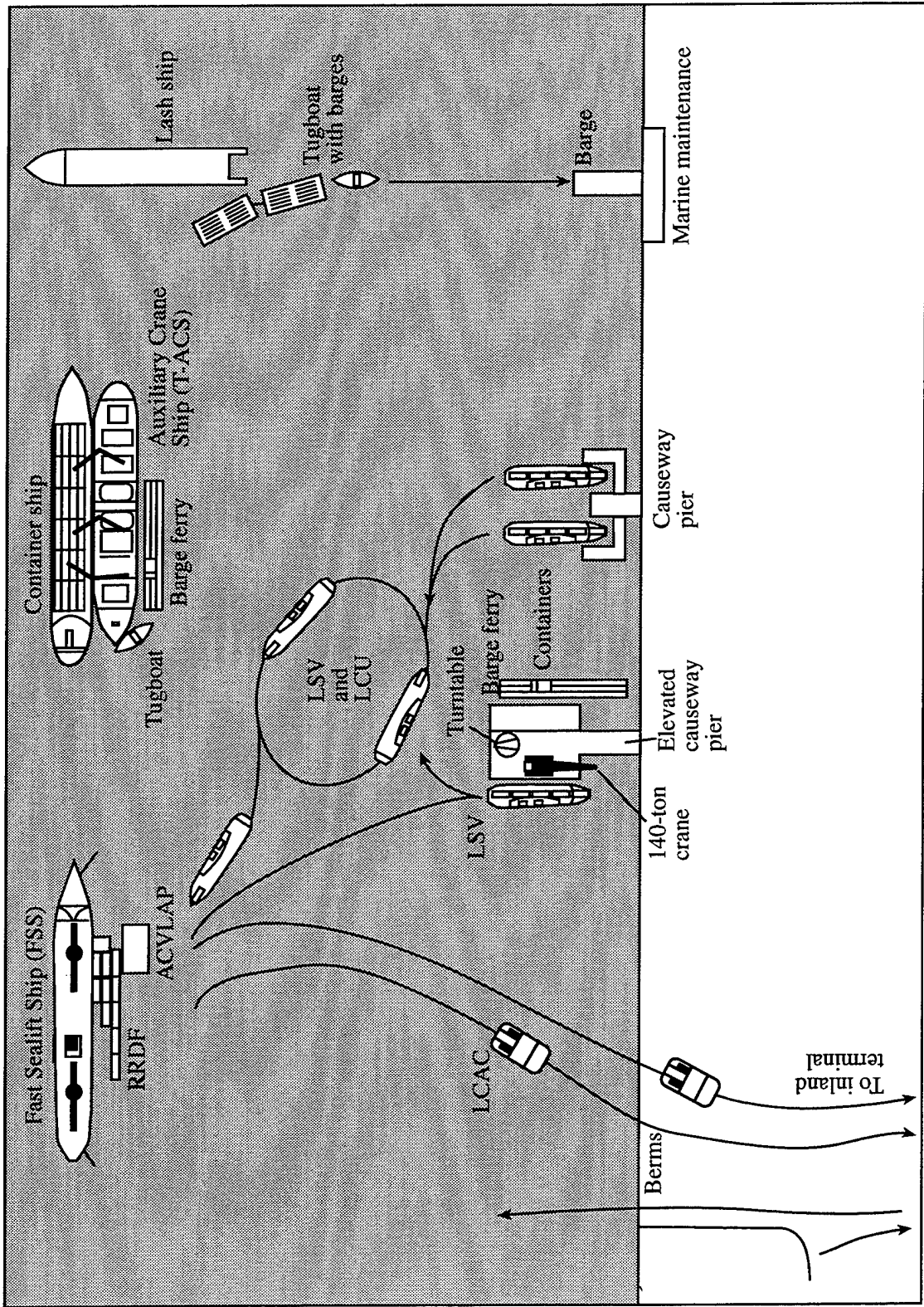*LOTS Operations Area (Fixed Port Augmentation)*

Figure C-2.
LOTS Operation Area (Bare Beach)

Joint Over the Shore Transportation
Estimator

Joint Over the Shore Transportation Estimator

HISTORICAL PERSPECTIVE

We developed the Joint Over the Shore Transportation Estimator (JOTE) model at the Logistics Management Institute (LMI) to better model instream discharge operations from large, ocean-going vessels into lighters that ferry materiel to shore. JOTE was first developed for use in an Army study of Logistics Over the Shore (LOTS). Later, JOTE was refined during the course of an earlier LMI report.[1] The study of the Joint LOTS (JLOTS) is not new, but the current emphasis on the topic is.

During the Cold War era, the only identified requirement for JLOTS was in the Persian Gulf and Korean Peninsula areas. The Military Services acquired a capability to meet this requirement. After the Iran and Iraq conflicts ended, the strategic vision shifted away from limited ports and onto areas of operation where there were deep draft ports readily available. The advent of many operations other than war (OOTW) and the real possibility of entering an area without a well-defined infrastructure has again shifted the DoD logistics community into examining the plausibility of conducting JLOTS operations to either join the combat force or sustain it where fixed facilities are unavailable or inadequate.

The issue is more than just applying existing assets to arising problems. Questions about the adequacy of current lighter assets and future procurements surround JLOTS operations. To sufficiently analyze these concerns, new, more powerful modeling tools were required.

MODEL OVERVIEW

The JOTE uses cargo lane assignments, operational readiness, lighter mix available, and sea state information to optimally assign watercraft trips per lane at the JLOTS site. The model minimizes the overall shortfall in cargo throughput as measured in short tons.

The JOTE is written in Visual Basic and uses the math programming optimization routine imbedded in Excel 5.0 to determine the solution set. The model runs on any personal computer (PC) capable of supporting Excel 5.0.

The model is configured to simultaneously optimize lighter assignments on up to 24 lanes. JOTE allows selection from 9 lighter types including the Landing

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[1] LMI Report JS502MR1, *Joint Logistics Over the Shore (JLOTS) – Assessment of Capabilities*, Peter J. Thede et al., September 1995.

Craft, Mechanized (LCM)-8; Landing Craft, Utility (LCU)-1600; LCU-2000; Logistics Support Vessel; Causeway System, Powered (CSP)+3; CSP+2; CSP+1; Heavy Lift Landing Craft, Air Cushioned (HLLCAC); and Landing Craft, Air Cushioned (LCAC). The lanes can be assigned to one of four types of discharge: roll-on/roll-off (RO/RO) wheel, RO/RO track, lift-on/roll-off (LO/RO) wheel, and lift-on/lift-off (LO/LO) operations.

MODEL INPUTS

The two types of model inputs are those specified at run time and those imbedded in JOTE's integral spreadsheet. The parameters imbedded in the spreadsheet include

◆ the average travel time for a lighter to make a round trip to a ship one nautical mile from shore and back (JOTE can accommodate distances up to 50 nautical miles);

◆ the average amount of time (by discharge lane) it takes a lighter to

► approach and moor at the ship,

► load,

► castoff and clear the ship,

► approach and moor at the beach or pier,

► unload at the beach or pier, and

► castoff and clear the beach or pier;

◆ the average load each lighter can carry, by discharge lane;

◆ the average fraction of time the sea state is 3 and above; and

◆ the operational readiness of the lighter fleet.

LMI gathered this information from a variety of sources including operations "after action" reports from JLOTS II and III, Joint planning factors, manufacturers' reports, and Marine Corps studies.

The inputs imbedded in the spreadsheet can be changed by a knowledgeable user. For example, during our analysis of the HLLCAC, we tried various configurations of speed and cargo-carrying capability with the HLLCAC to see where its best performance lay on the weight/speed curve. The cells for operational readiness rate for the lighter fleet and the percentage of time the sea state is above 2 (i.e., SS2) are displayed with the output for the model; they are readily accessible.

The run time parameters for JOTE include

♦ the distance from the ship to the shore,

♦ the lighter fleet available by type of lighter,

♦ the number of discharge lanes in the operation,

♦ the type of discharge being accomplished on each lane, and

♦ the tonnage to be moved on each lane.

The user can easily modify these parameters and run the model again to see the impacts of changing assumptions. For example, if the weather is much worse than anticipated, it may require the commander to staff more lanes or increase the number of lighters available for JLOTS operations. A sudden change in the type of cargo may require that lighters be reassigned to different lanes.

The JOTE allows the user to specify changes in the lane type and tonnage assignments from day to day. So, if an RO/RO track lane is completely discharged, the model allows the user to specify that he/she is using the recently vacated RO/RO track lanes for RO/RO wheel discharge, etc.

MODEL OUTPUTS

JOTE displays the trips required by day by lighter type in each lane to achieve the optimal throughput capability, subject to operational readiness, lane, lighter, and tonnage constraints. In Table D-1, we see the model has assigned one LSV run for the day to each of the Lanes 1, 2, 3, and 4; JOTE has assigned four LCU-2000 runs to Lanes 6, 7, and 9. No assignment has been made for the other craft. (Note that it could be the same LSV or several making these runs.)

Table D-1.
Output from JOTE (Lane Assignments)

Lane	LCM-8	LCU-1600	LCU-2000	LSV
1	0	0	0	1
2	0	0	0	1
3	0	0	0	1
4	0	0	0	1
5	0	0	0	0
6	0	0	4	0
7	0	0	4	0
8	0	0	0	0
9	0	0	4	0
10	0	0	0	0

In Table D-2, we see that JOTE displays the type of lane and the short tons remaining after the projected movements for the day. JOTE displays the same results for the case when sea state conditions are factored into a site's production. For example, Lane 1 is a RO/RO track lane. There were 306 short tons moved on Lane 1 that day, which left 19 hours under ideal conditions. However, once the sea state conditions were taken into account, the number of slack hours on that lane dropped to seven.

Table D-2.
Output from JOTE (Sea State)

Lane	Short tons moved	Short tons left	Discharge type	Hours left	Hours left with SS	Short tons shortfall with SS
1	306	0	RRDF track	19	7	0
2	416	0	RRDF vehicle	16	4	0
3	416	0	RRDF vehicle	16	4	0

JOTE also displays the usage by lighter type. In Table D-3 we see that there were 18 LCU-2000s available for use in the JLOTS operation. Of these, 3 were used by the model on the lanes assigned that day. This leaves a surplus capability of 15 craft. However, given the operational readiness rating, this leaves only 12 LCU-2000s which can be assigned to other sites or missions.

Table D-3.
Output from JOTE (Lighter Availability)

	LCM-8	LCU-1600	LCU-2000
Available	8	3	18
Used	0	0	3
Remaining	8	3	15
Remaining given OR	7	3	12

MODEL DESCRIPTION

JOTE uses math programming techniques to arrive at the optimal assignment of lighters to lanes. This section describes that math program in detail.

Throughout this section, we use i to index the lighter type (e.g., LSV and LCU-1600), j to index the lane, and k to specify the type of cargo discharge taking place. The decision variable for JOTE is the trips by lighter type by lane; we call

this T_{ij}. For example, T_{23} would refer to the number of lighter trips made by lighter type 2 in Lane 3. The variable P_{ik} is the average productivity for lighter type i when carrying cargo type k. We denote the amount of cargo to be carried in each row as C_j. We define the boolean variable D_{jk}, which is defined as

$$D_{jk} = \left\{ \begin{array}{c} 1 \text{ if Lane j is assigned to carry cargo type k} \\ 0 \text{ else} \ldots \end{array} \right\}.$$

We can then describe the tonnage moved across lane j as

$$\sum_i \sum_k D_{jk} P_{ik} T_{ij}$$

Further, we can describe the shortfall as

$$C_j - \sum_i \sum_k D_{jk} P_{ik} T_{ij}$$

Our objective in JOTE is

$$\text{Minimize } \sum_j (C_j - \sum_i \sum_k D_{jk} P_{ik} T_{ij}).$$

Some constraints need to be followed. For example, each lighter cannot be worked more than 20 hours per day. We will call the maximum number of lighters available for type i lighter to be M_i. Another factor in lighter availability is the operational readiness rate of the lighters. For example, if you have 20 lighters, but the lighters are broken down 50 percent of the time, then you really only have 10 lighters, on average, available to work for you. We call the operational readiness rate for lighter type i to be R_i. Lighters are required both at the ship and the shore. For safety reasons, a lighter must be allowed to castoff and clear before another lighter can approach and moor. Naturally, the lighter must load and unload. All these things take time. We refer to the total of this time as A_{ik} for lighter type i carrying cargo type k. Likewise, we call the maximum time either on shore or at the ship for these administrative procedures A'_{ik}. The distance from the ship to the shore in nautical miles is L, and the amount of time it takes for lighter type i to make a round trip at one nautical mile is G_i. Now, we can describe the constraint on each type of lighter as being

$$\forall i \sum_j \left[(T_{ij}(LG_i + \sum_k D_{jk} A_{ik}) \right] \leq 0.84 \, R_i \, M_i.$$

The constraints for the individual lanes are calculated using a similar procedure. If we call S the fraction of time that the sea state is 3 or above (currently, JLOTS transload operations cease during these conditions), then the constraint on the lanes is

$$\forall j \sum_i \sum_k D_{jk} A'_{ik} T_{ij} \leq 0.84 \, S.$$

It would be desirable for the model to only assign enough lighter on a lane to carry the cargo required there. Then we have a production constraint of

$$\forall j \sum_i \sum_k D_{jk} P_{ik} T_{ij} \leq C_j.$$

Also, we want our decision variables to be integral and nonnegative, which leads to the constraints

$$\forall i, j \; T_{ij} \geq 0, T_{ij} \in Z.$$

In total, the math program for JOTE can be described as

$$\text{Minimize } \sum_j (C_j - \sum_i \sum_k D_{jk} P_{ik} T_{ij}),$$

subject to

$$\forall i \sum_j (T_{ij}(LG_i + \sum_k D_{jk} A_{ik})) \leq 0.84 \, R_i M_i$$

$$\forall j \sum_i \sum_k D_{jk} A_{ik} T_{ij} \leq 0.84 \, S$$

$$\forall j \sum_i \sum_k D_{jk} P_{ik} T_{ij} \leq C_j$$

$$\forall i, j \geq 0, T_{ij} \in Z.$$

Glossary

Glossary

AAV	=	Amphibious Assault Vehicle
ACVLAP	=	Air Cushioned Vehicle Landing Platform
ATF	=	Amphibious Task Force
CINC	=	Commander in Chief
CNA	=	Center for Naval Analysis
CSP	=	Causeway Systems, Powered
DoN	=	Department of the Navy
dwt	=	deadweight tons
HLLCAC	=	Heavy Lift Landing Craft, Air-Cushioned
HMMWV	=	High Mobility Multi-purpose Wheeled Vehicle
JLOTS	=	Joint Logistics Over the Shore
JOTE	=	Joint Over the Shore Transportation Estimator
LCAC	=	Landing Craft, Air-Cushioned
LCM	=	Landing Craft, Mechanized
LCU	=	Landing Craft, Utility
LMI	=	Logistics Management Institute
LO/LO	=	lift-on/lift-off
LOTS	=	Logistics Over the Shore
LSV	=	Logistics Support Vessel
LVS	=	Logistics Vehicle System
MHE	=	materials handling equipment
MPF	=	Maritime Prepositioned Force

NM	=	nautical miles
OOTW	=	operations other than war
OTH	=	over-the-horizon
PC	=	personal computer
RO/RO	=	roll-on/roll-off
RRDF	=	RO/RO Discharge Facility
RRF	=	Ready Reserve Facility
RTCH	=	Rough Terrain Container Handler
RTCH&CONT	=	Rough Terrain Container Handler and Container
SS	=	sea state
S/T	=	short ton
TEU	=	20-foot equivalent unit
USMC	=	United States Marine Corps
UTH	=	under-the-horizon

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13. ABSTRACT *(Maximum 200 words)*

This assessment looks at a number of alternatives for employing air-cushioned lighters in Logistics Over the Shore (LOTS) operations. The evaluation focuses on determining the suitability of the proposed Heavy Lift Landing Craft, Air Cushioned (HLLCAC) to perform a LOTS or joint LOTS role. The area of Joint Logistics Over The Shore (JLOTS) has received renewed emphasis over the past several years. The Army and Naval Services and each of the five regional Commanders in Chief (CINCs) have stated requirements for LOTS or JLOTS operations in time of conflict. This assessment evaluates the capability of the HLLCAC, and the current Landing Craft, Air Cushioned (LCAC), to perform JLOTS missions specified by two of the regional CINCs. It also explores, from a Navy LOTS perspective, whether making these lighters available for Maritime Prepositioned Force (MPF) ship discharge would reduce the time required to conduct instream or offshore operations. To aid in this analysis, a new analytic tool is introduced and utilized, the Joint Over-the-shore Transportation Estimator (JOTE). The assessment reveals that the current version of air-cushioned craft, the LCAC, is most suited for LOTS or JLOTS operations conducted inside 10 nautical miles from shore. The proposed HLLCAC would be better employed with the Amphibious Task Force beyond that distance. The assessment underscores the need for obtaining Air Cushioned Vehicle Landing Platforms which enable the LCAC to fly-on, load, and then fly-off a stable floating platform adjacent to a cargo ship.

14. SUBJECT TERMS

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Landing Craft, Air Cushioned
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