DEPARTMENT OF DEFENSE

Joint Test Director

Joint Logistics Over-the-Shore II

Test and Evaluation

DEPLOYMENT TEST REPORT

JLOTS II

AUGUST 1985

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JOINT TEST DIRECTOR
JOINT LOGISTICS OVER THE SHORE (JLOTS II)
NAVAL AMPHIBIOUS BASE
LITTLE CREEK, NORFOLK, VA 23521

15 August 1985

To: Distribution List

Subj: JLOTS II Deployment Phase Report

1. The subject report is approved for distribution.

2. This Joint Test Program addressed many aspects of logistics over the shore operations. The Deployment Phase examined the critical issues concerning deployment of selected outsized and hard to handle military equipment essential for offshore cargo ship discharge and over the beach delivery systems. The results reported in this document clarify many of the issues.

N. P. FERRARO

Rear Admiral, SC, U.S. Navy

TABLE OF CONTENTS

Page

Page

LIST OF FIGURES

Page

Page

Page

LIST OF TABLES

Page

LIST OF ABBREVIATONS

ABS	American Bureau of Shipping
AFOE	Assault Follow-On Echelon
AE	Assault Echelon
ALS	Amphibious Logistic System
BMC	Boatswain Mate, Chief
CAF	Container Adapter Frames
CLF	Cantilever Lift Frame
C.G.	Center of Gravity
CSP	Causeway Section, Powered
DTNSRDC	David Taylor Naval Ship R&D Center
ELCAS	Elevated Causeway
EOCS	Equipment Operator Senior Chief
FLS	Marine Corps Field Logistics System
ISW	internal spudwells
JLOTS	Joint Logistics Over-the-Shore
LACV	Lighter Air Cushion Vehicle
LOA	length overall
LARC	Lighter Amphibious Resupply Cargo
LASH	Lighter Aboard Ship
LCU	Land Craft, Utility
LCM	Landing Craft, Mechanized
LOTS	Logistics Over-the-Shore
MAF	Marine Amphibious Force
MSC	Military Sealift Command
NCEL	Naval Civil Engineering Laboratory
NOB	Naval Operations Base
NSC	Naval Supply Center
PHIBCB	Amphibious Construction Battalion
POL	Petroleum Oil Lubricant
RO/RO	Roll-On/Roll-Off
SLWT	Side-Loadable Warping Tug
TCDF	Temporary Container Discharge Facility

1.0 PURPOSE OF TEST

1.1 INTRODUCTION

In the future, 90 to 95 percent of the supplies and equipment required by operating military forces will be transported in strategic sealift made up of modern merchant vessels. The supplies will be containerized to the extent possible, and the containerships will be nonself-sustaining for the most part. When the military operations are conducted in areas where port facilities for containerships are not available for either military or geographic reasons, then the supplies and equipment must be brought ashore in Logistics Over-the-Shore (LOTS) operations.

The Joint Logistics Over-the-Shore (JLOTS) II joint test and evaluation project is intended to assess the Services' current capability to conduct Assault Follow-On Echelon (AFOE) and LOTS operations. This is the latest in a series of joint tests begun in 1970 to aid in the development of a container handling capability in AFOE/LOTS operations. JLOTS II is separated into three test phases. Phase I, the Deployment Test, is to assess the capabilities to deploy the logistics delivery equipment in merchant ships to an operating area. Phase II, the Roll-On/Roll-Off (RO/RO) Test, is to assess the capability to assemble, install, and operate an offshore RO/RO Discharge Facility and to deliver vehicular cargo ashore from merchant RO/RO vessels. Phase III, the Throughput Test, is to assess the Services' capability to install and use their delivery systems for container, breakbulk, and bulk liquid cargo and to define the operating performance of the combined systems in a joint test. This report covers the Phase I, Deployment Test.

1.2 OPERATIONAL CONTEXT

Traditional planning for amphibious assault operations calls for the delivery of the AFOE beginning on day D+5 under the assumption that by then the Assault Echelon (AE) will have secured the beach area and that the build-up of equipment and supplies ashore can commence. AFOE material for a Marine Amphibious Force (MAF) is transported mainly aboard merchant-type ships and is containerized to the maximum extent possible. The delivery timetable provides for delivery ashore of a 60-day supply, in addition to the supplies consumed by the force, by D+30. Thus, it is important to establish the AFOE delivery system ready for operation in a timely manner.

The systems required to bring AFOE breakbulk cargo ashore are essentially the same as those for the AE breakbulk. However, the systems for offloading modern RO/RO, container, and bulk liquid ships include many heavy, out-sized equipments. In order to meet the material movement timetable, it is important to deploy these equipments and systems with minimum disassembly. Included are ship unloading systems, ship-to-shore lighterage, lighterage unloading systems and ashore container handling equipment as well as mooring and discharge systems for tankers carrying bulk Petroleum Oil Lubricant (POL) products.

Although the timetable is usually not as constrained, the discharge systems and equipments for LOTS operations are similar to those for AFOE operations. However, the quantity of cargo to be moved may be larger and the duration of use may be longer.

1.3 SCOPE

Deployment encompasses all steps necessary to load, transport, and offload all needed equipment, personnel, and logistics supplies to an objective area in order to establish a throughput capability. Much of the Navy Amphibious Logistics System (ALS), Marine Corps Field Logistics System (FLS), and Army Logistics Over-the-Shore (LOTS) equipment is standard military gear for which deployment requirements are well known. JLOTS II concentrated on testing the ability to deploy selected new or hard-to-handle items on Lighter Aboard Ship (LASH) and SEABEE vessels. The test was conducted to assess the ability of these specialized sealift resources to deploy the selected equipment. Time, procedures, manpower, and special equipment requirements are the important factors in deployment operations. Backloading of ALS equipment was addressed in a minimum test of one item to address the ability to retrieve the equipment from the operating area.

LASH and SEABEE ships were chosen for these tests because they represent a unique heavy lift capability in the U.S. Flag merchant fleet. They are designed to transport cargo stowed in barges. The barge ships are self-sustaining in that they have onboard means to lift loaded barges from the water and transport them to stowage locations on the ship.

1.4 OBJECTIVES

There are five Objectives in the overall JLOTS II joint test and evaluation.

Objective 1

Assess the capability to deploy on designated commercial ships selected outsized military equipment needed to conduct over-the-shore operations.

Objective 2

Assess the installation and preparation of over-the-shore systems and equipment for cargo operations.

Objective 3

Assess the over-the-shore systems and equipment capabilities for sustained container, breakbulk, vehicle, and bulk POL systems operations.

Objective 4

Assess the capabilities of the Services' to manage and control the movement of container and breakbulk cargo in sustained throughput operations over-the-shore.

Objective 5

Assess the capability of the Services' to transition from a Navy ALS/Marine Corps FLS operation to an Army LOTS operation.

The Deployment Test covers the following Subobjectives of Objective 1 above.

Subobjective 1.1. - Evaluate the deployment of selected JLOTS equipment on a LASH ship.

Subobjective 1.2. - Evaluate the deployment of selected JLOTS equipment on a SEABEE ship.

1.5 METHOD OF ACCOMPLISHMENT

The JLOTS II Deployment Test was planned and conducted to meet the deployment test objectives and guidance contained in the JLOTS II Test Design[1]*. A Deployment Phase Field Test Plan[2], prepared by the Joint Test Directorate, gave details on test equipment, procedures, and desired schedules. A Deployment Phase Data Management Plan[3] identified data requirements and covered plans for data collection and reduction.

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* A complete listing of references is given on page 146.

2.0 SEABEE TEST

2.1 TEST COMPONENTS

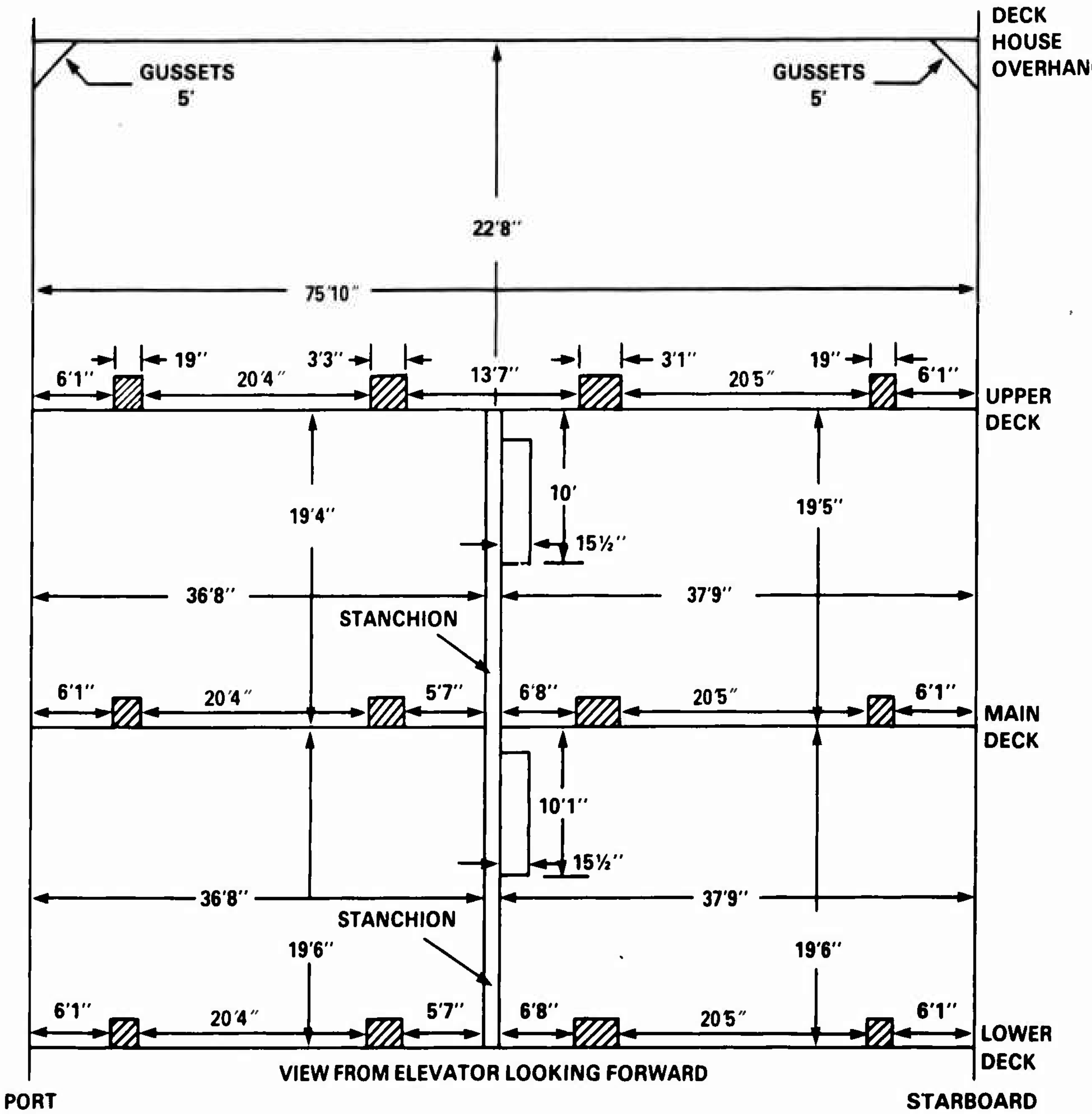
The Deployment Test consisted of the SEABEE ship, the military test cargo, and special lifting and interfacing equipment required to handle the cargo.

2.1.1 SEABEE SHIP

The SEABEE ship that participated in the test was the SS ALMERIA LYKES, chartered for the test by the Military Sealift Command from Lykes Brothers Steamship Company. The SS ALMERIA LYKES, one of three SEABEE ships in the U.S. Flag merchant fleet, is a three-deck vessel designed to carry barges loaded with cargo. It can also carry liquid bulk cargo in its tanks. Through the use of adapter frames, it can carry containers instead of barges on the weather deck. Some of the relevant features are listed below:

LOA	873′ 9"
Beam, Upper Deck	105′ 10"
Length, Elevator Platform	104′ 0"
Width, Elevator Platform	74′ 8"
Elevator Capacity	2000 Lton
Elevator Lift Speed	4-ft per min (fpm)
Transporter Capacity (ea)	1000 Ltons
Transporter Transit Speed	80/30 fpm (light/heavy)

The upper deck has no centerline obstructions and thus, is available for stowing cargo up to the maximum width that can be lifted by the elevator. There is a 22-ft vertical clearance from the deck to the under side of the bridge-type superstructure which is located 516-ft forward of the transom of the ship. Account must be made of the heights of the pedestals (21 in.) and of any mounting platforms used to support the load. The deck aft of the superstructure is free of overhead contraints. The main and lower deck have centerline stanchions effectively dividing the deck into port and starboard halves. The SEABEE deck clearances are given on Figure 1.



NOTE: 1. BARGE SECURING JACKS EXTEND DOWN 5" FROM OVERHEAD.

2. ▨ BARGE PEDESTALS AND TRANSPORTER BOXES EXTEND 21" ABOVE DECKS.

Figure 1 - SEABEE Deck Clearances

The SEABEE barge elevator is capable of lifting two SEABEE barges with a combined weight of 2000 long tons to one of three deck levels. Barges are nominally 98-ft long x 35-ft wide x 17-ft high. As the elevator is raised, the barges settle onto the elevator pedestals shown in Figure 2. The elevator is then raised to the desired deck where the barges are moved forward by transporters. There are two transporters per ship, one starboard and one port. They are electrically driven on tracks between the rows of pedestals. Figure 3 is a view looking forward on the upper deck showing the deck pedestals and transporters. Since there are only two transporters, they must be prepositioned by the elevator to the deck where barges are to be moved. When the elevator arrives at the desired deck with barges, the transporters are driven under the

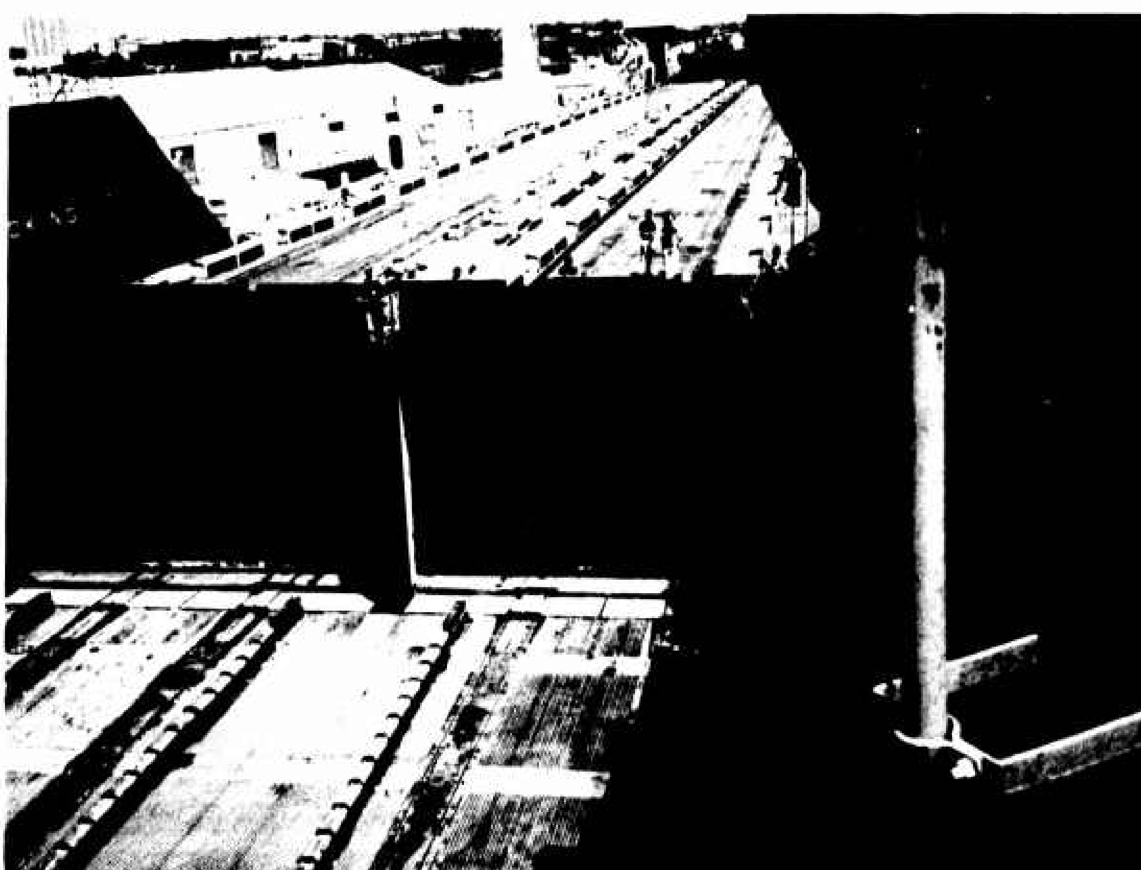


Figure 2 - SEABEE Barge Elevator

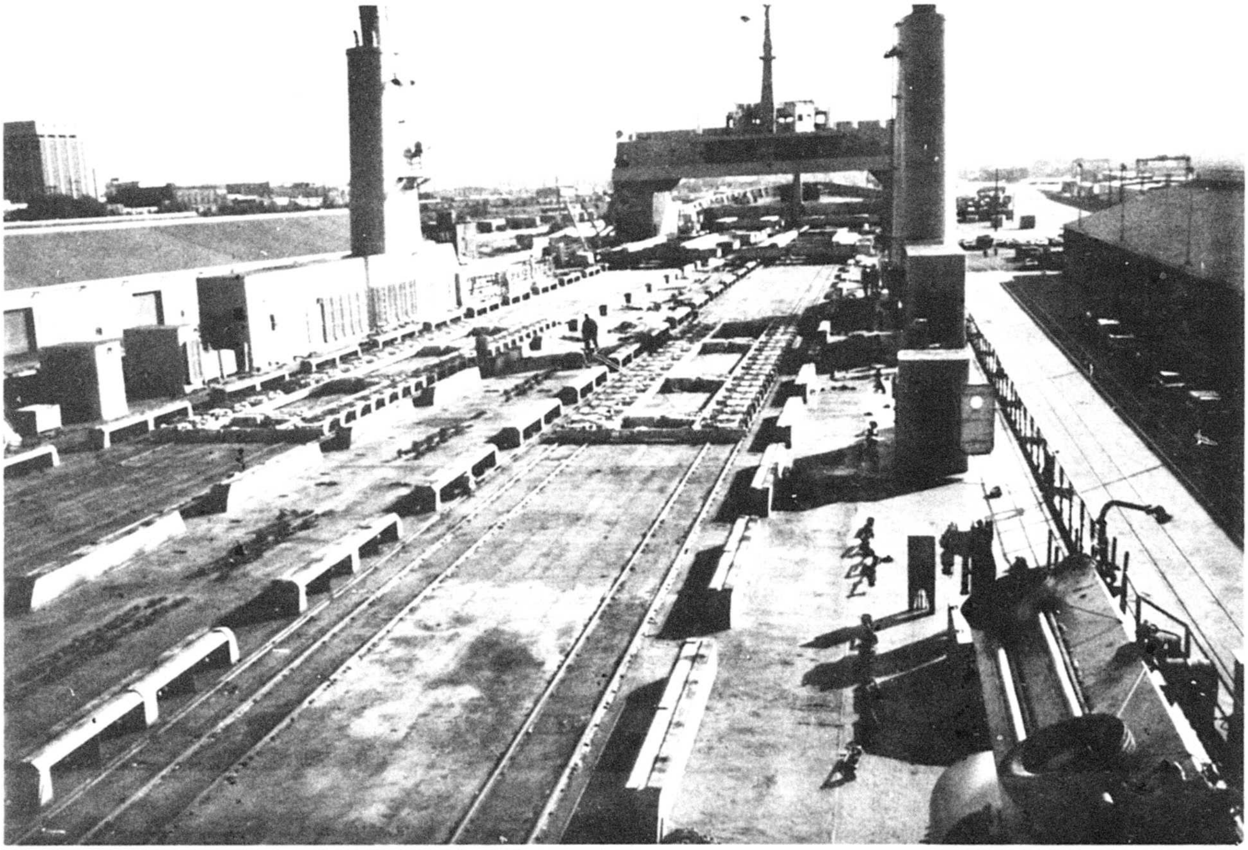


Figure 3 - Transporters and Pedestals on SEABEE Upper Deck

barges, their hydraulic jacks raise the barges off the elevator's pedestals, and the transporter delivers them forward to desired stowage positions where they are lowered onto pedestals mounted on deck. Reversing this operation unloads barges from the ship.

To meet the requirement of the JLOTS II test, the transporters were rewired for a two-mode operation:

- In the primary mode, the transporters could be operated independently, as originally designed, for normal SEABEE usage.
- In the other mode, the transporters could be operated synchronously and abreast of each other in order to transport the 60-ft wide TCDF along the deck without overloading or dragging either transporter's propulsion system.

Elevator operations are automated and controlled from a station in the starboard wingwall. Transporter operations are controlled from stations on each deck.

Barges are stowed aboard ship with their centerline parallel to the ship's centerline. On the enclosed decks (lower and main), they are secured in place by exerting a downward force on their decks with overhead hydraulic jacks. On the upper deck they are secured on pedestals with large Peck and Hale lashing gear.

Containers (not carried in barges) are loaded aboard the ship by pier-side cranes and placed on Container Adapter Frames (CAF), Figure 4 and 5, designed to rest on the pedestals on deck. Figure 6 is a view of a transporter lowering an adaptor frame onto pedestals. Note the bevels underneath to prevent sideways slipping of the frame on the pedestal. Containers are carried only on the upper deck and are placed on corner fittings and secured with Peck and Hale lashing gear.

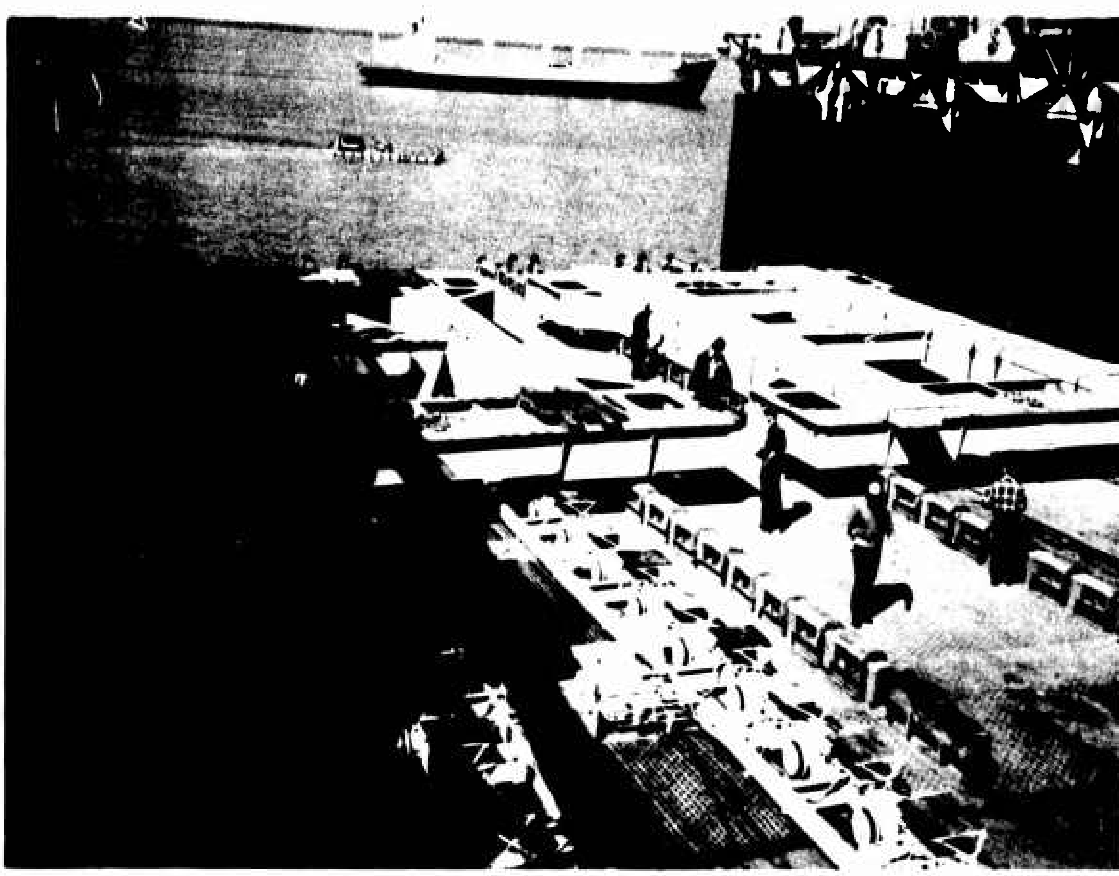


Figure 4 - Container Adaptor Frames (CAF's) on SEABEE Elevator Pedestals

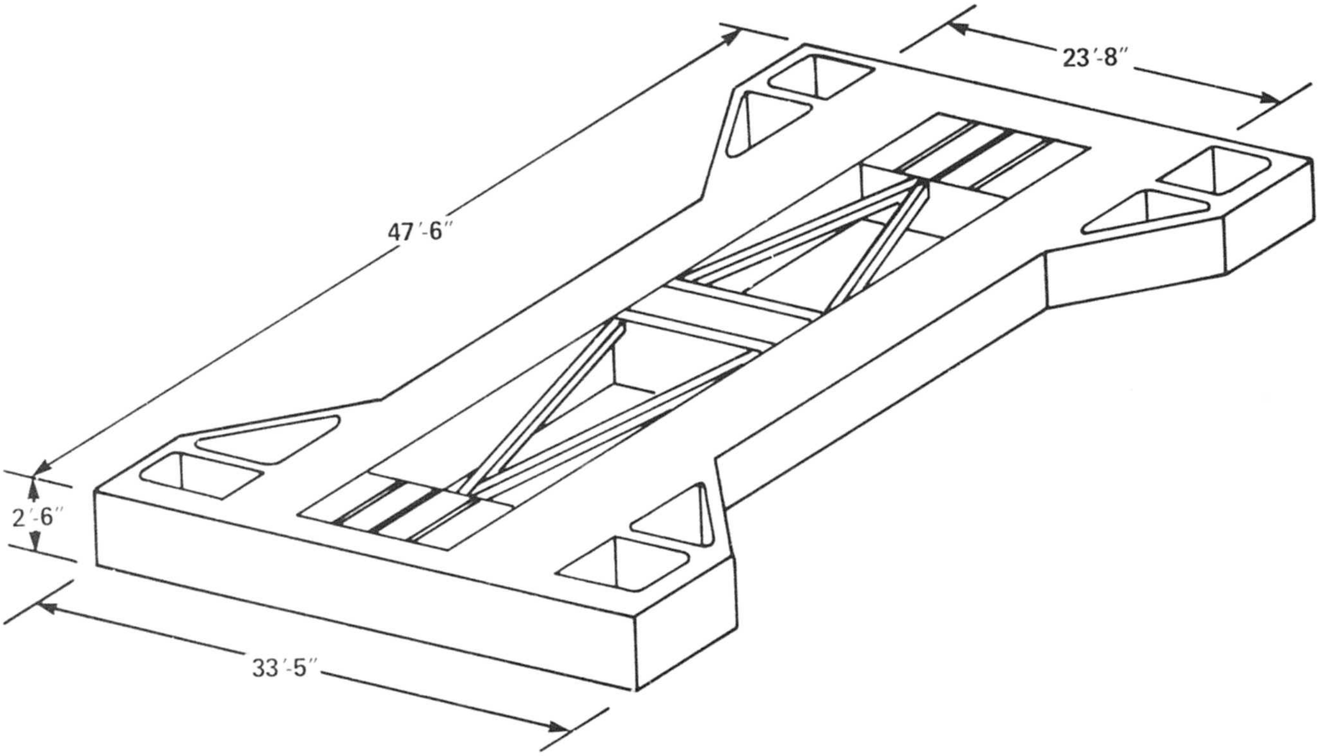


Figure 5 - Container Adaptor Frame (CAF)

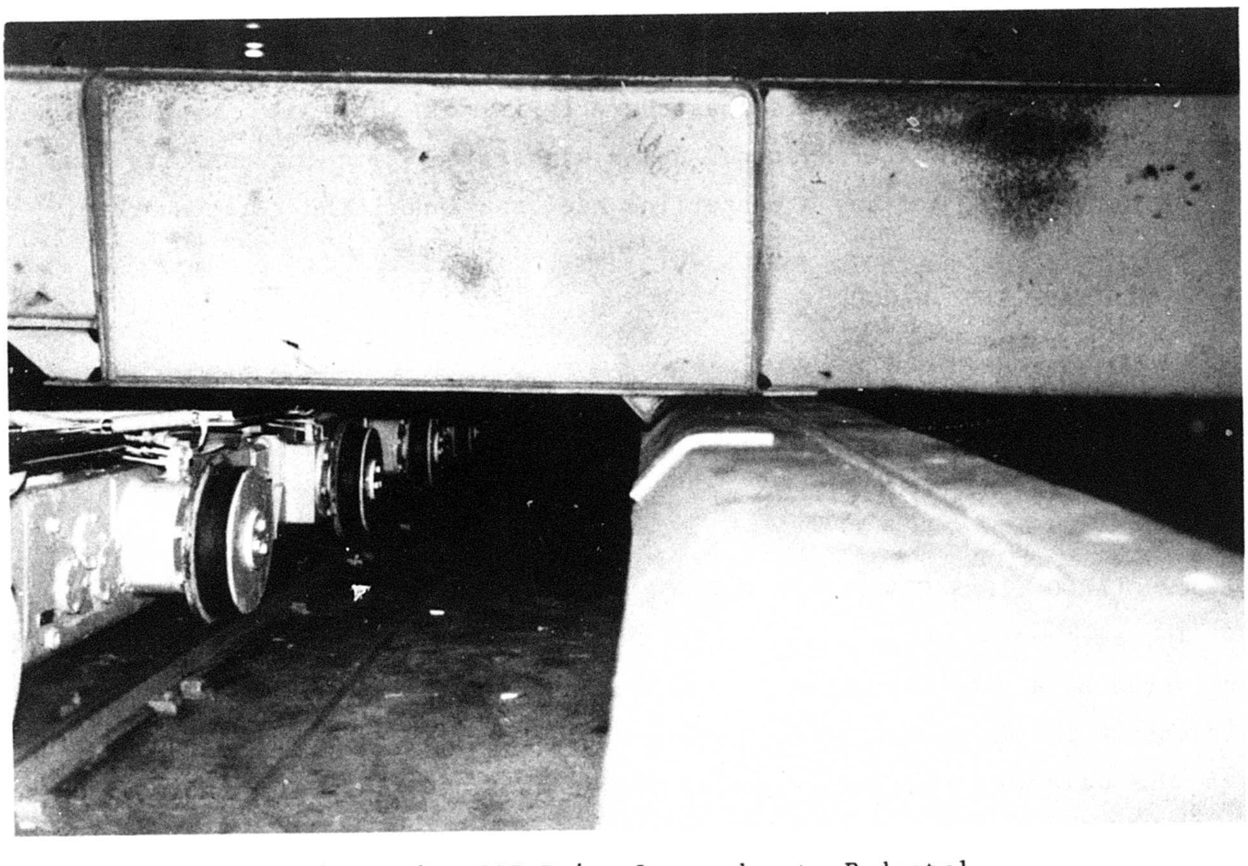


Figure 6 - CAF Being Lowered onto Pedestal

2.1.2 SEABEE INTERFACE HARDWARE

Since normal cargo operations aboard a SEABEE ship involves the ship's elevator and transporter, it is important to devise ways to handle military equipment items using these systems. One consideration is that the ship is designed to load items which float (e.g., SEABEE barges). Therefore, the military equipment that is candidate for deployment by SEABEE ship must either itself be a buoyant waterborne item or be equipment on or in a barge or craft made up into a floating unit for loading and unloading on the ship. Another consideration is that the load be configured to rest on the pedestals on which SEABEE barges are stowed.

The SEABEE CAF's are compatible with the pedestal and transporter system and they provide a load supporting area that is adaptable for use by many candidate military loads. Therefore, they have been chosen as an interface device for most of the test loads. Appropriate load bearing and supporting surfaces have been added to the CAF's as required by the specific cargo items. Since the CAF's are not used on the elevator in commercial operations, they are designed as box beam structures that are nominally buoyant. As interface devices, they must be secured to the elevator and be made free flooding by opening access plates. As an alternative to CAF's, a device called a SEABEE Skid has been designed. It also has characteristics that are compatible with the pedestal/transporter system, has a higher load carrying capacity than the CAF, is nonbuoyant, and has a centerline keel to support the tugs embarked.

2.1.3 MILITARY TEST CARGO

2.1.3.1 SELECTED TEST CARGO ITEMS

The military cargo items selected for testing on the SEABEE ship are listed in Table 1.

2.1.3.2 CARGO ITEMS CONSIDERED BUT NOT SELECTED FOR TEST

The self-elevating barge pier (B-DeLong) with caissons was originally considered as a candidate load. To overcome the problem of having to erect the caissons at the discharge site, consideration was given to shipping the barge with the caissons vertically positioned in their jacking wells. It was determined that the resulting lashing requirements for storm sea conditions was

TABLE 1 - MILITARY EQUIPMENTS SELECTED FOR DEPLOYMENT TESTING ON SEABEE SHIP

Load NC	Description	Approximate (1) Weight (Thousands of Pounds)	Length (ft)	Width (ft)	Height(2) (ft)
1	Cube Barge	233	100	40	11'9"
1	LACV-30	84	77	38	22'7"
2	LARC-LX (2) ea with 20-Ton Crane	273 ea	63	27	20'
3	TCDF	1925	150	60	30'11"
4	100' Tug Boat	683	107	27	67'1"
4	65' Tug Boat	229	71	20	47'4"
5	LCU 1466 Cl (each with (25-Ton Truck Crane))	594	115	34	46'
5	LCU 1667 Cl	555	135	30	44'4"

(1) Vehicle plus cargo weight (including 10% fuel, water, stores).

(2) Extreme vehicle height plus CAF height (2'6") or skid height (2'0") plus pedestal height (1'9") plus typical dunnage height (4"-14"). LACV-30 height is without radar mast.

prohibitive so the barge pier was dropped from the load list. Lifting the barge without caissons was not considered because there is no way to elevate/install the caissons (as presently designed) in the objective area.

When considering the feasibility of lifting the Army's BD crane barge (equivalent to Navy YD barge) with the SEABEE elevator, there are two problem areas which are a direct result of the cantilever loads imposed by the length of the barge (140 ft). The first concerns the ability of the individual elevator hoists to handle the imposed loads and the second concerns the ability of the barge structure to withstand the bending moment forces which would be imposed by the lift. The lift could be made, however, by removing 164.5 short tons of the fixed concrete ballast in the BD barge. Since the ballast is required to trim the BD barge in its operational environment, the barge would have to be reballasted in the objective area. Therefore, the BD barge crane was dropped from the list of candidate loads to be lifted by the SEABEE ship during the JLOTS II deployment test.

The fuel barge was dropped from the candidate list of loads because the stresses induced by the lift of a full fuel barge could have failed the structure. Also, it was determined that there were safety violations involved with the stowage aboard ship of a fuel-laden barge. An empty fuel barge was not considered because only one was available and the Army did not want to take it out of service for cleaning to satisfy U.S. Coast Guard regulations. Also, an empty fuel barge was not considered a practical test of the system since it was well within the limits of the SEABEE elevator lift capacity.

Other loads originally considered for this deployment loadout were the Landing Craft, Mechanized (LCM)-8 and the BC barge. These loads were later deleted since they had been successfully lifted aboard a SEABEE vessel in an earlier test.

2.1.4 SUPPORT EQUIPMENT

During loadout of the SEABEE ship at the Newport News Marine Terminal, the support equipment used included a pier-side gantry crane to position the CAF's and SEABEE skids on the ship prior to loading the test cargo. During loadout in port and offloading in the test area, Army tugs were used to move the TCDF into/out of the ship's elevator well. All other test cargo items entered/left the well under their own power. Once in the well, the ship's positioning winches could take over for final positioning of the craft over the CAF's or skids secured to the elevator.

2.1.5 OPERATING UNITS

The operating units participating in the SEABEE test were all from the Army's Seventh Transportation Group (Terminal) since all the test cargo was Army equipment. Personnel from each of the commands supplying test cargo were present to operate the equipment as necessary and to give guidance in handling procedures. Stevedoring services were arranged for by the ship's crew.

2.1.6 TEST AREA

The SEABEE test was conducted in the Norfolk, Virginia area. Ship loadout was conducted at a pier in the Newport News Marine Terminal, Newport News, Virginia. The offload test was conducted at an anchorage approximately one mile off Fort Story, Virginia. The test ended with the test articles afloat in the test area.

2.2 PRETEST PREPARATIONS

Initial activities in preparing for the SEABEE test included developing a candidate list of test cargo items for deployment. This was a coordinated effort involving the Joint Test Directorate staff and appropriate Army commands. With the candidate list in hand, a marine engineering and consulting firm was contracted to develop a loading plan that would define the necessary equipment and procedures for deploying the candidate test items aboard SEABEE ships. The plan described the use of CAF's to support each test item on the elevator and deck pedestals. Where necessary, specific CAF modifications were designed and dunnage arrangement was identified. A system of paint markings on the ship's transom and side hulls of the elevator well was developed to aid in aligning test items over the submerged CAF's. An arrangement of cable lashings was designed to secure each test item on deck for ship transit through storm sea conditions.

The newly designed SEABEE skid (Figure 7) was used as the interface device for both the Army 100- and 65-ft tugboats. Extensive structure additions would have been required to modify CAF's to support the tugs.

According to the charter contract for the SEABEE ship, the owner was responsible for all modifications required to make the CAF's and SEABEE skids interface with the selected test loads and to install additional padeyes and other tiedown points on the ship as necessary. The ship owner contracted locally for the CAF and skid modifications which were accomplished aboard ship. Additional padeyes and tiedown points were judged to be unnecessary. Figures 9, 17, 25, and 27 in Section 2.3 are photographs of modified CAF's and skids.

2.3 SUMMARY OF TEST EVENTS

SEABEE ship test events are detailed in the following Sections.

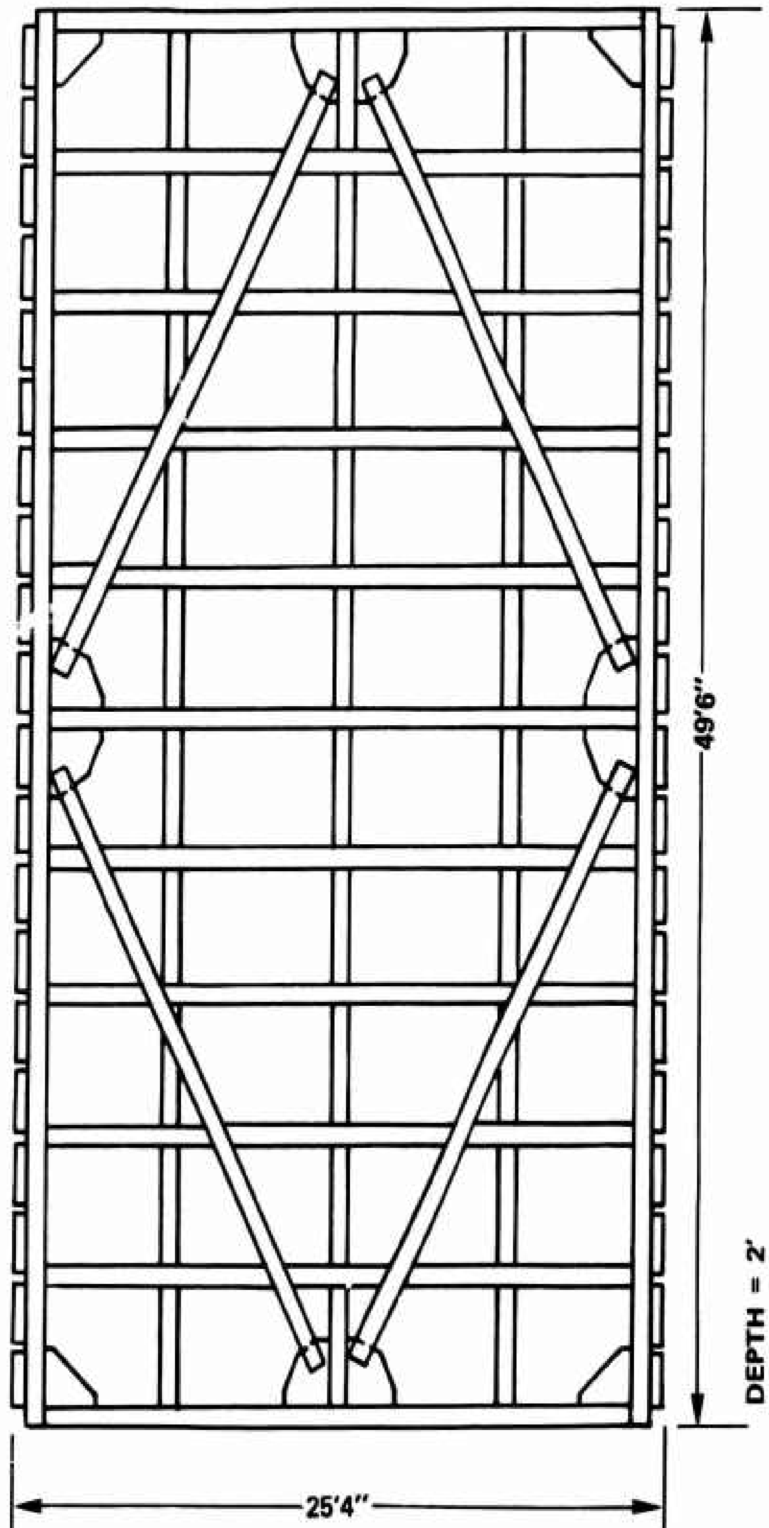


Figure 7 - SEABEE Skid

2.3.1 TEST SCHEDULE

The SEABEE Deployment Tests were conducted during the period 5 through 9 May 1984.

The SEABEE ship, ALMERIA LYKES, was loaded with selected military test cargo items while moored to a pier in the Newport News Maritime Terminal and the equipment was offloaded from the ship at an anchorage off Fort Story, Virginia. The actual test events are listed below:

2 May - Ship arrival at pierside, Newport News.
Discharge SEABEE barges, position CAF's to accomplish specific modifications.

3 May - Modify CAF's

4 May - Modify CAF's

5 May - Load Cube Barge, LACV-30, Two LARC-LX's

6 May - Load TCDF, Tugs (Delay, to Improve Tug Chock System)

7 May - Load Tugs (complete), LCU's, Shift to Anchorage at Ft Story, Offload LCU's

8 May - Offload Tugs, TCDF, LARC's, LACV-30

9 May - Ship returned to port, Cube Barge offloaded, CAF's restored

2.3.2 SEABEE SHIP LOADOUT PROCEDURE

The general procedure for loading the ship was similar for each test item. Deviations occurred primarily as a result of their size, shape, and powering. Each item was maneuvered into the elevator well, landed onto container adaptor frames or SEABEE skids, except for the Lighter Amphibious Resupply Cargo (LARC)-LX's, and stowed on the upper deck. Each lift included two test items, side-by-side on the elevator, except for the Temporary Container Discharge Facility (TCDF) which spanned most of the elevator width. The loading procedure for each lift was as follows:

- Position the required adaptor frames or skids on the elevator, using the transporters and secure them to the pedestals to preclude shifting when submerged. The frames were aligned to paint marks placed on the pedestals prior to test operations (Figure 8 shows typical marks).

- Lower the elevator to a predesignated submergence to clear the test item's draft. When modified container adaptor frames were involved, the

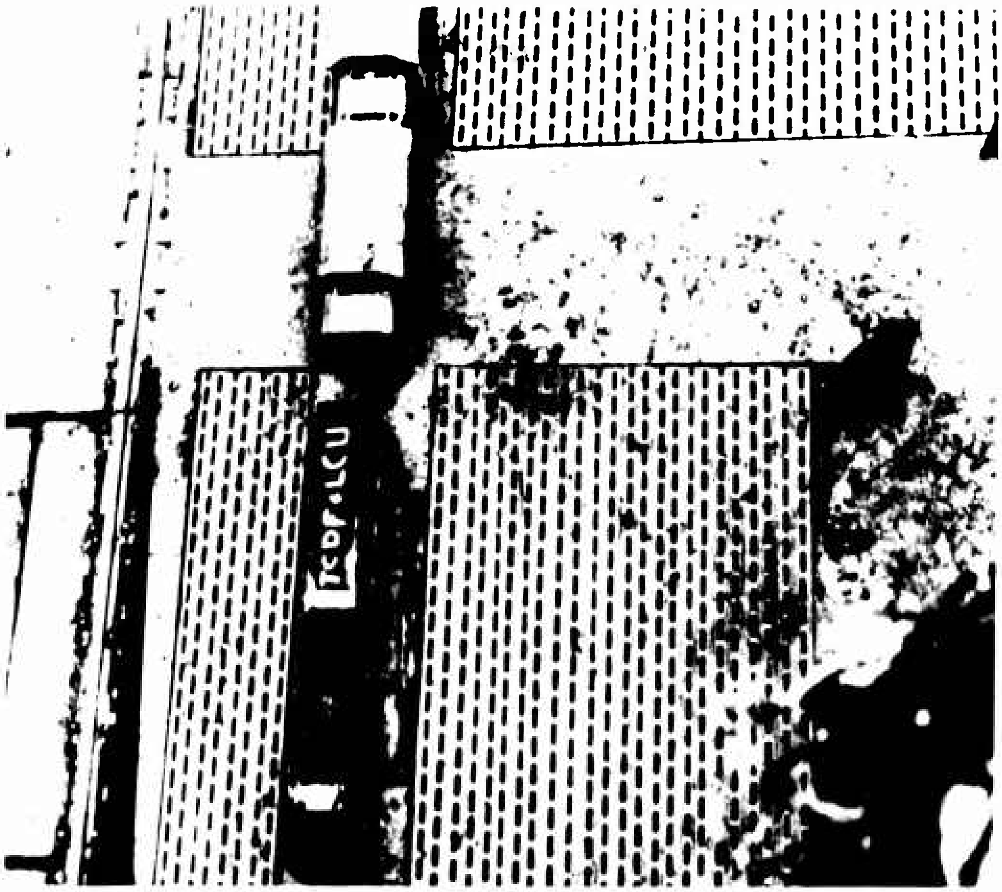


Figure 8 - Typical Alignment Marks for Placing
CAF's on SEABEE Pedestals

elevator would pause for several minutes with the frame awash to allow flooding through open access ports to eliminate buoyancy.

- All test items entered the elevator-well under their own power except for the TCDF, which was guided by the 65- and 100-ft Army tugs.

- Each craft was secured on its outboard side to two ship positioning lines normally used to position barges over the elevator. The craft were moored together by two breast lines passed between them.

- The craft were aligned over their respective adaptor frames using alignment marks on the ship's transom and sidewalls. This was accomplished by adjustments in the positioning and breast lines. The alignment operation was directed by an Army supervisor stationed at the ship's transom on the upper deck. He transmitted directions to the craft operators by radio, hand signals, and verbally. The ship's mate stood by to provide assistance and to direct ship's personnel operating the positioning lines, the elevator, and the transporters.

- The elevator was lifted up into contact with the floating cargo items when they were aligned and then continued to the main deck level where the system was visually checked for alignment and unforeseen problems. Additonal chocking and dunnage were added, if considered necessary, before proceeding.
- The elevator continued to the upper deck and the transporters moved the cargo items off the elevator and forward to designated stowage positions and lowered them onto deck pedestals.
- Cargo items were secured as required for ship transit to Fort Story. The Lighter, Air Cushion Vehicle (LACV)-30 was secured with storm sea lashings in accordance with the test plan.
- The transporter retrieved the next set of CAF's from the main deck and positioned them on the elevator for the next lift.

2.3.2.1 ORDER OF SEABEE LIFTS

The order in which the test cargo items were loaded aboard the SEABEE ship is listed in Table 2 below:

TABLE 2 - ORDER OF LIFT OF CARGO ITEMS

			Position on Elevator	
Lift	Item	Orientation	Port	Starboard
1	Cube Barge	Bow First	X	
1	LACV-30	Bow First		X
2	LARC-LX	Stern First	X	
2	LARC-LX	Stern First		X
3	TCDF	Stern First	X	X
4	100-Ton Tug	Bow First	X	
4	65-Ton Tug	Bow First		X
5	1466 LCU	Stern First	X	
5	1667 LCU	Stern First		X

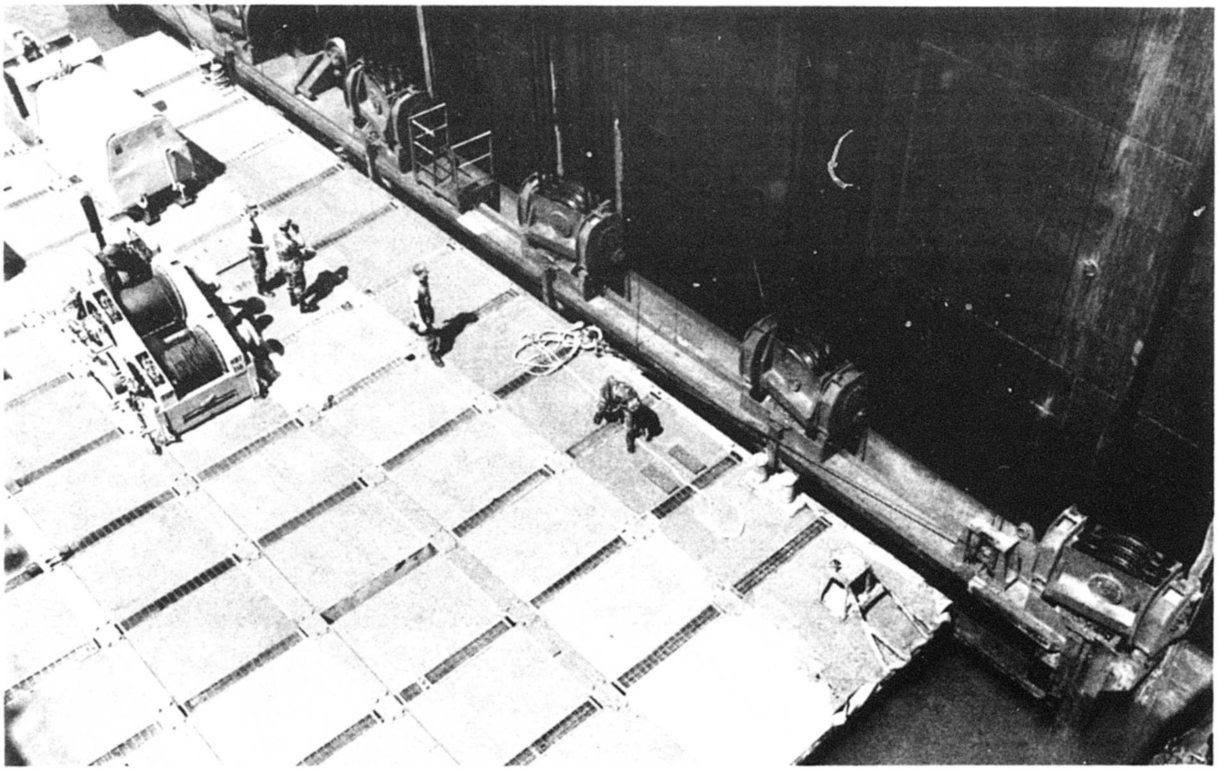


Figure 11 - Cube Barge Secured in SEABEE Elevator Well

Figure 12 - Army LACV-30 Entering SEABEE Elevator Well

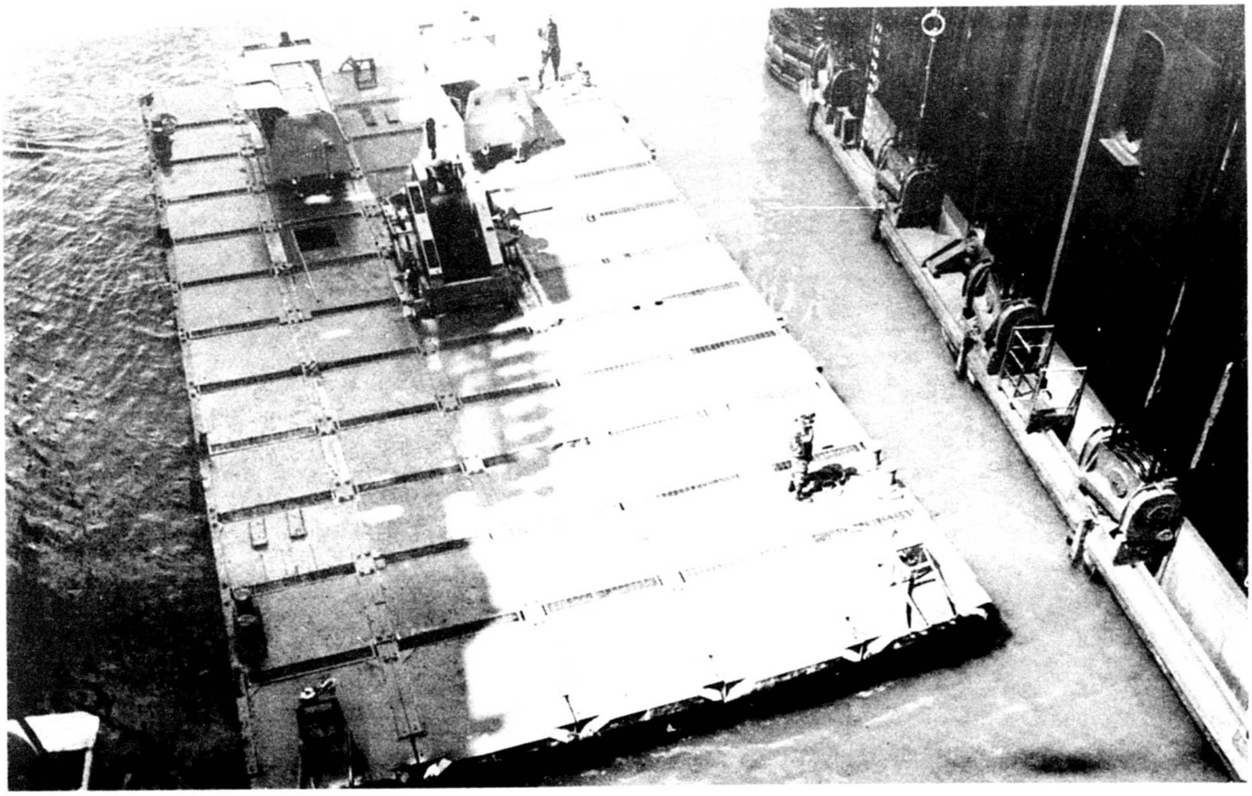


Figure 10 - Cube Barge Entering Port Side of SEABEE Elevator Well

the side of the well while passing and securing lines. Once the ship's two positioning lines were retrieved by the barge crew, they were secured as shown in Figure 11.

Figure 12 shows the LACV-30 entering the starboard slot in the elevator well under its own power. It drifted against the starboard sidewall and used it as a guide as it completed its entry.

The craft were moored together with breast lines and positioned over their respective CAF's by adjusting tensions on the ship's positioning lines and the breast lines until the craft lined up with paint markings on the ship's transom and sidewalls.

The elevator was raised to the upper deck where the CAF's were unlashed, transported forward on the transporters, and stowed on deck pedestals as shown in Figures 13 and 14. Lashings were applied to the LACV-30 according to a plan in TM55-1930-2218-14 for storm sea conditions as a test exercise.

Lift 2: LARC-LX's

The amphibious LARC's require no CAF's for loading aboard ship so the transporters were stowed on the main deck to clear the upper deck for the LARC's

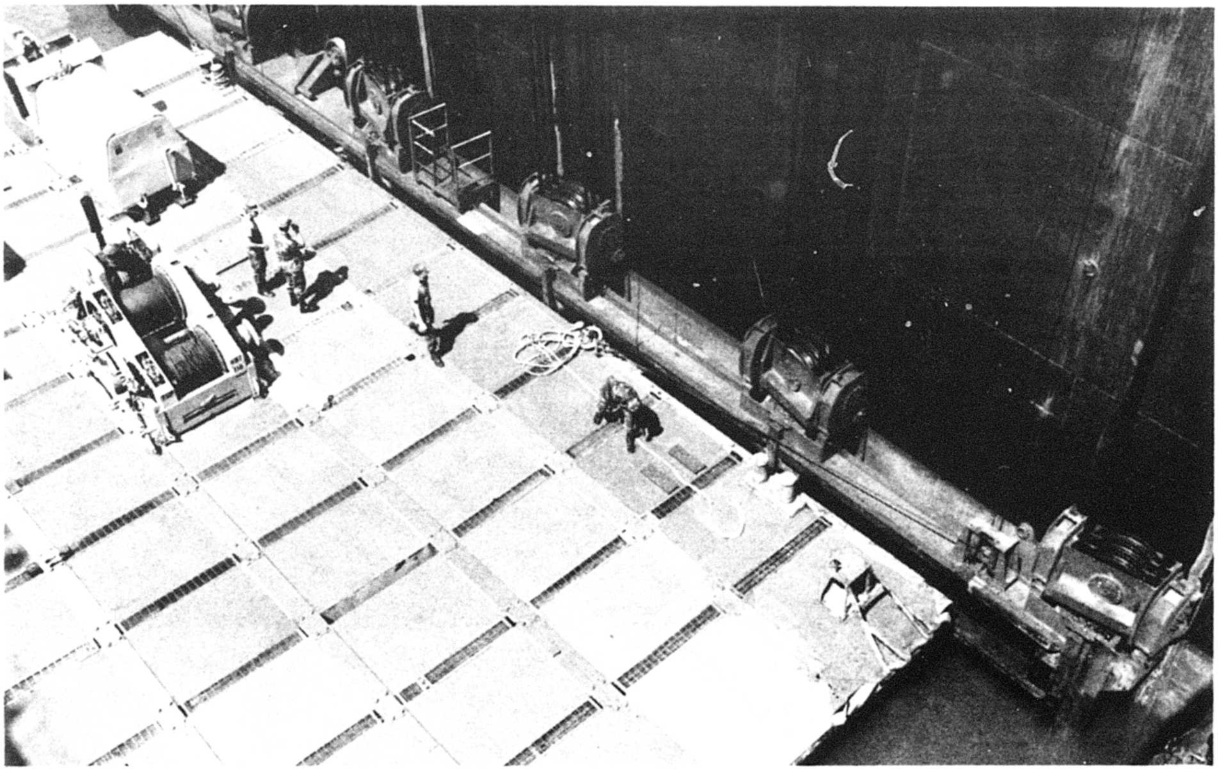


Figure 11 - Cube Barge Secured in SEABEE Elevator Well

Figure 12 - Army LACV-30 Entering SEABEE Elevator Well

Figure 13 - Cube Barge Lashed to SEABEE Deck

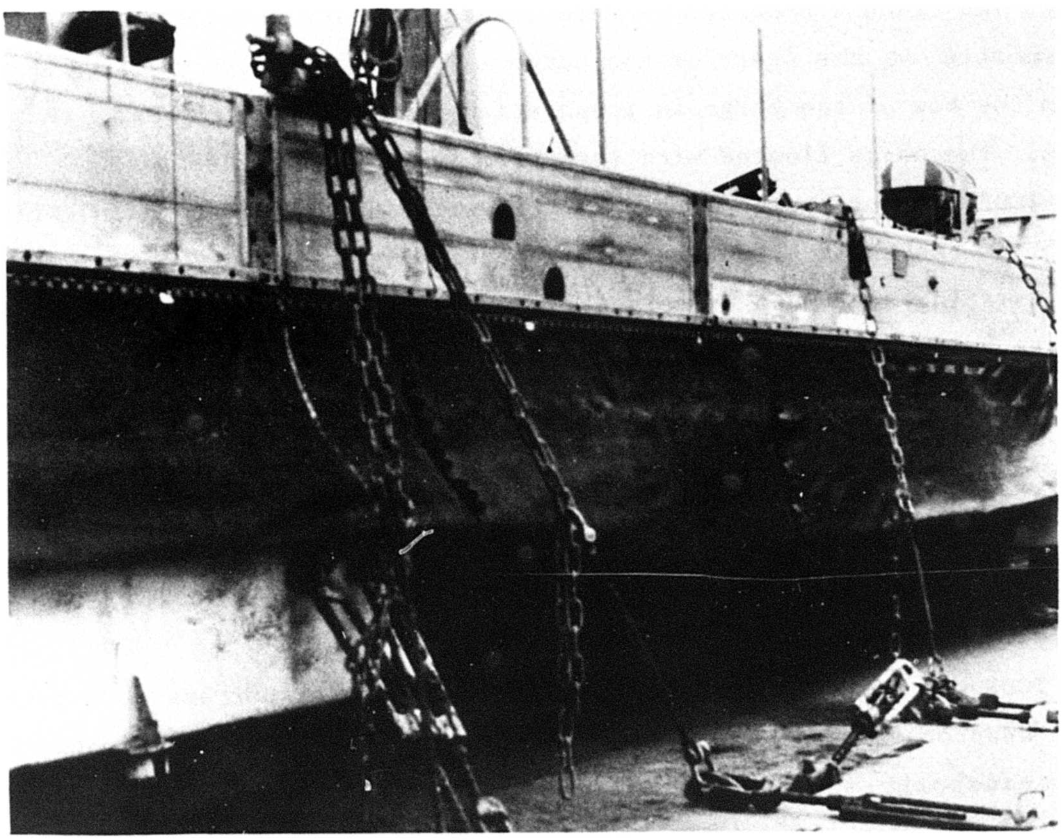


Figure 14 - LACV-30 Lashed to SEABEE Deck

transit to their stowage positions. They both carried 25-ton truck cranes for use in reassembling the TCDF boom prior to launching it in the deployment area.

Both craft backed into the well; the port craft entering first. Current, at the time, caused drifting from port to starboard until lines were passed and secured. Figure 15 shows the LARC's secured together with breast lines and held in place with ship's positioning lines. They were aligned so that their wheels bracketed the pedestals on the submerged elevator.

Because the TCDF must be partly lowered on the elevator with its crane pointing shipwise forward during boom reassembly, the LARC's must be stowed forward of the TCDF and facing shipwise aft so the truck cranes aboard the LARC's can disembark adjacent to the TCDF boom assembly area.

Upon reaching the upper deck, the LARC's were directed forward, around some deck obstacles, to stowage behind the Cube Barge and LACV-30 and lashed to the deck as shown in Figure 16.

Lift 3: TCDF

The TCDF had been prepared for loading aboard the SEABEE by removing the tip and intermediate crane boom sections, as required by the crane manufacturer, and lowering the remaining boom stub onto a pedestal on the bow of the barge. The crane's upper works were lashed with its counterweights resting on a framework at the stern of the barge. The disassembled boom sections were stowed on the bow of the barge in preparation for assembly aboard ship prior to launch. The barge floated with zero trim in this configuration.

The TCDF adaptor frames were outfitted with dunnage as shown in Figure 17. Rough-cut timbers about 4 in. x 6 in. in section were strapped onto the frame to preclude drifting away when submerged. The straps were welded to the CAF frame.

First lift. The TCDF was guided, bow-first, into the well over the submerged elevator with the assist of the Army tugs as shown in Figure 18. Problems encountered during entry and positioning of the TCDF are discussed in the Analysis section.

The clear length of the TCDF CAF's (two pairs) on the elevator was about 100 ft. Therefore, approximately 50 ft of the 150-ft TCDF projected, unsupported, astern of the elevator.

The TCDF was raised to the upper deck, and the transporters were positioned under the adaptor frames. The system was switched to synchronous mode so that the two transporters would lift the load and transit the deck as one unit. However, the lift was incomplete, because the transporters were unable to lift the after CAF's free of the pedestals. This is illustrated in Figure 19.

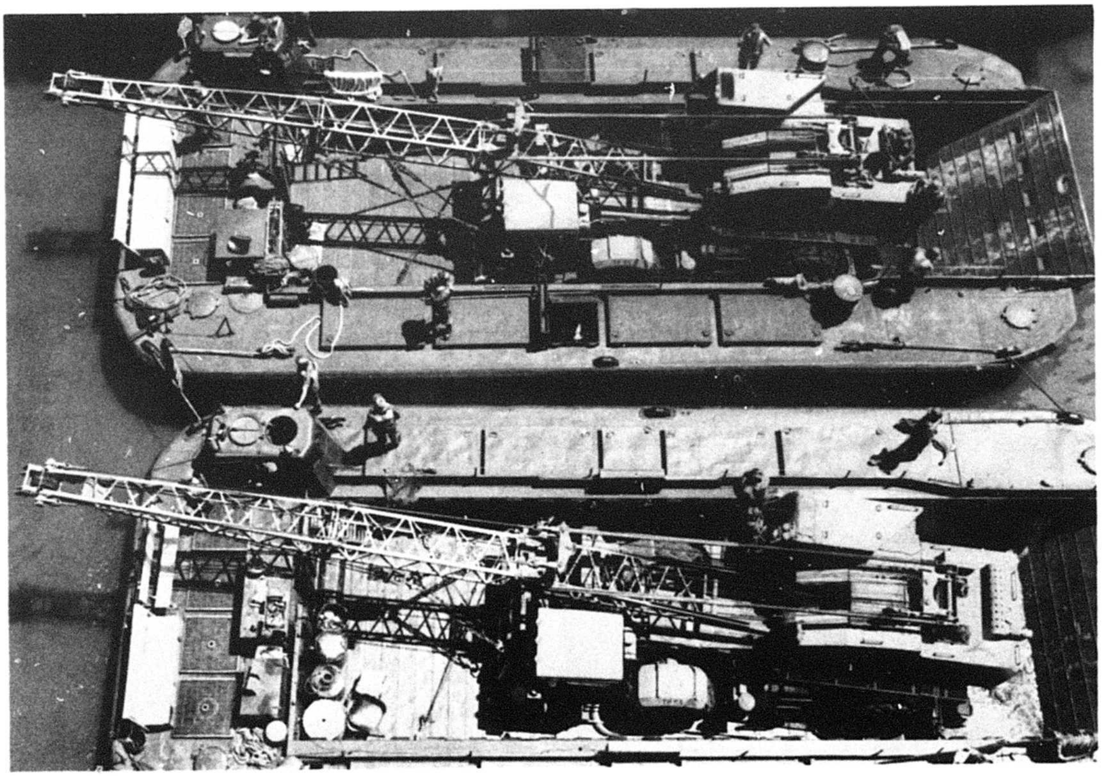


Figure 15 - LARC-LX's Secured in SEABEE Well

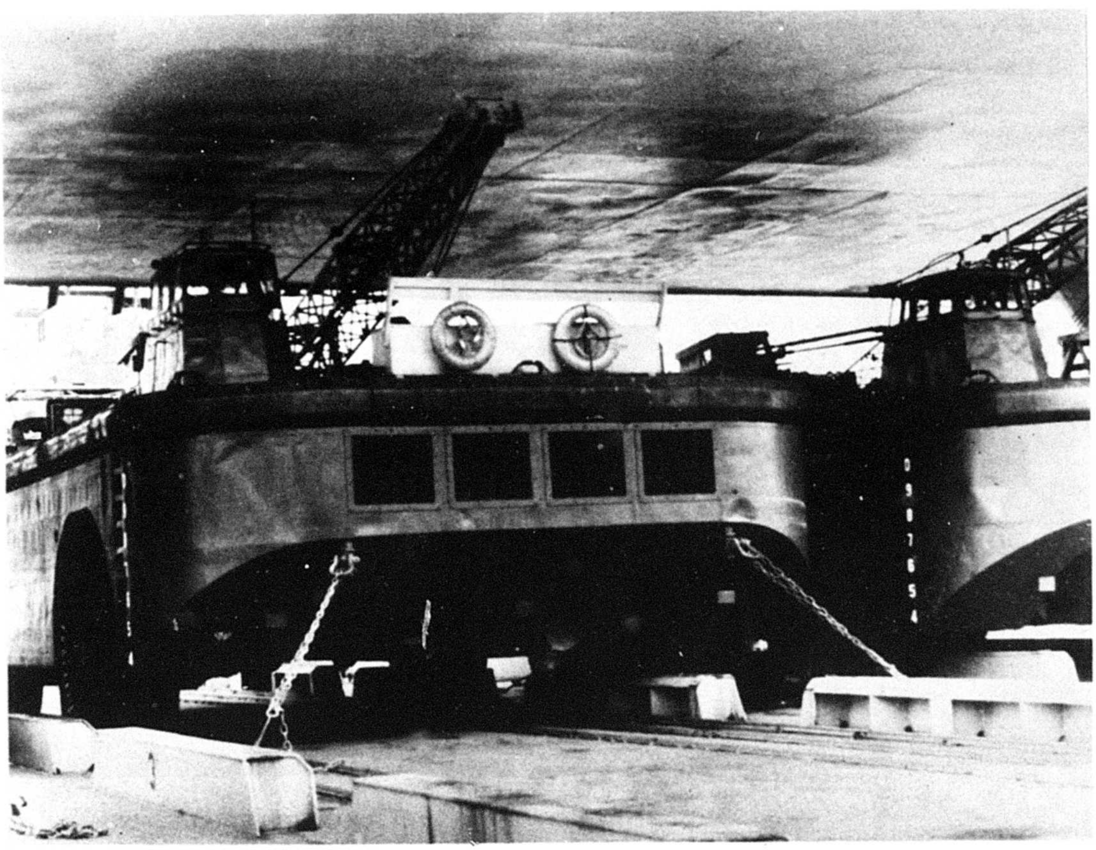


Figure 16 - LARC-LX Lashed to SEABEE Deck

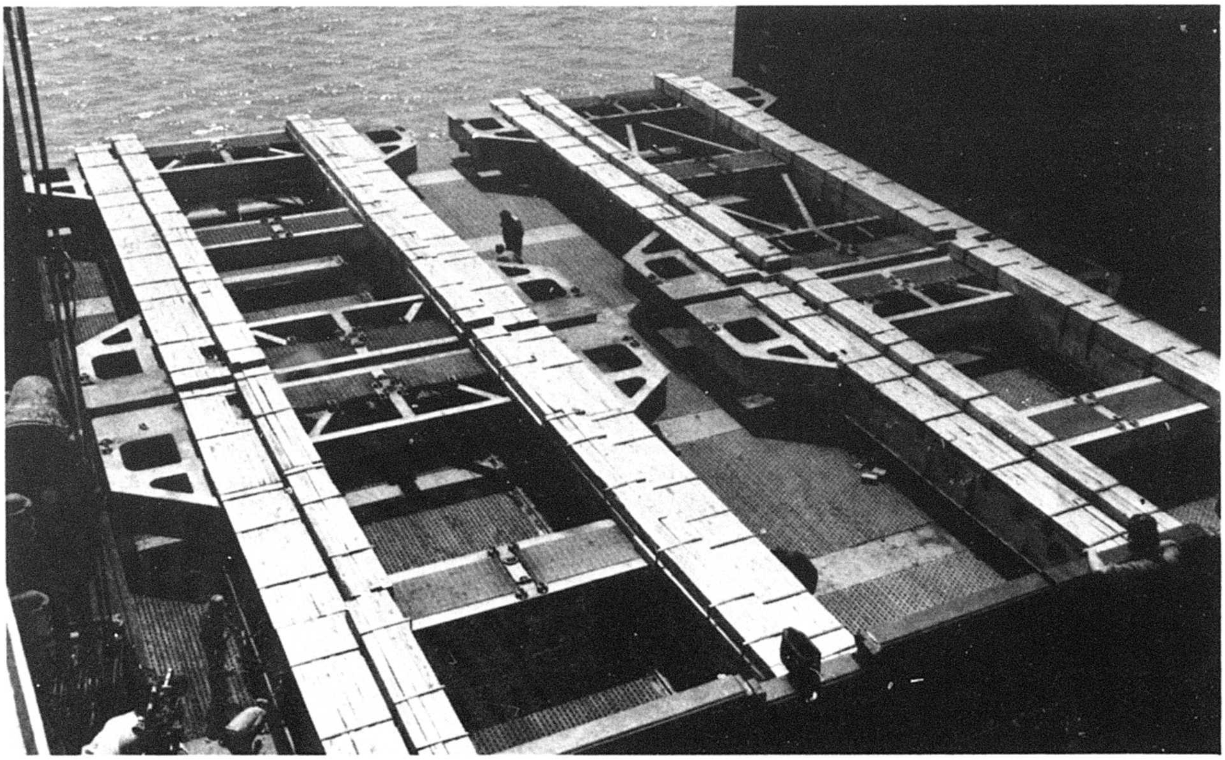


Figure 17 - CAF's Modified to Lift TCDF

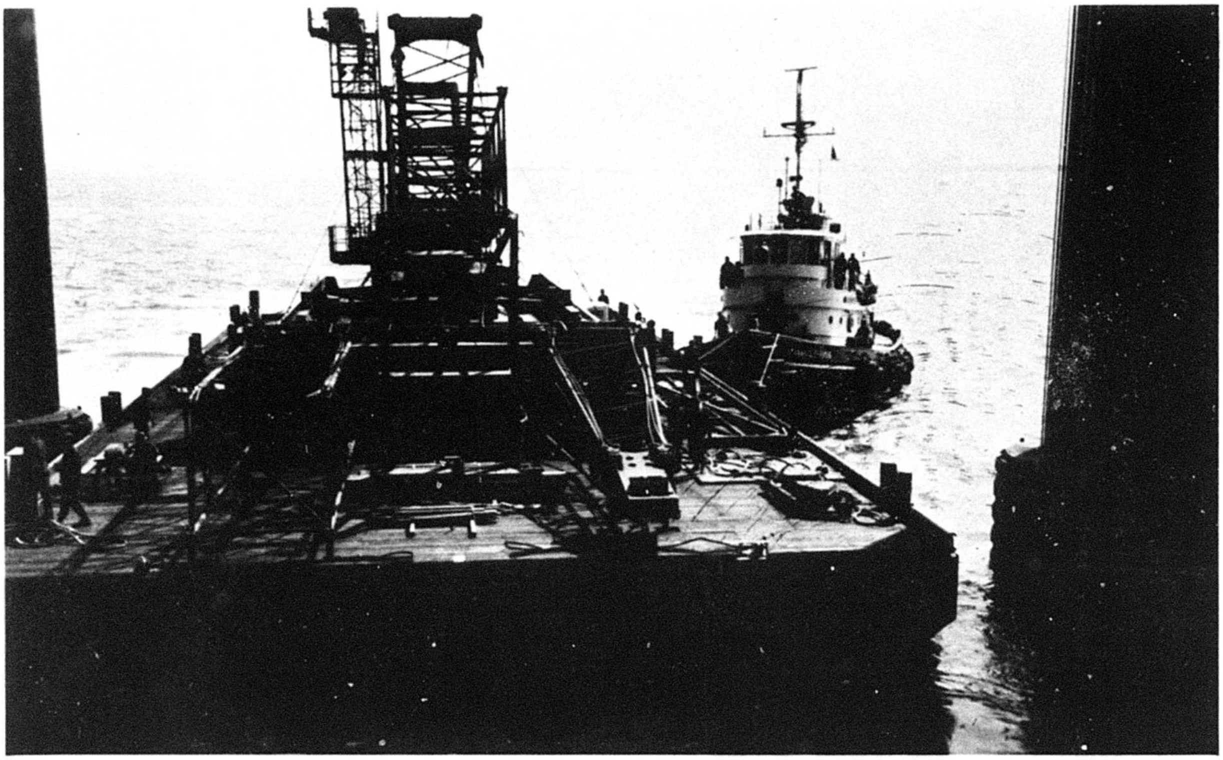


Figure 18 - TCDF Being Guided into SEABEE Elevator Well 100-Foot Army Tug

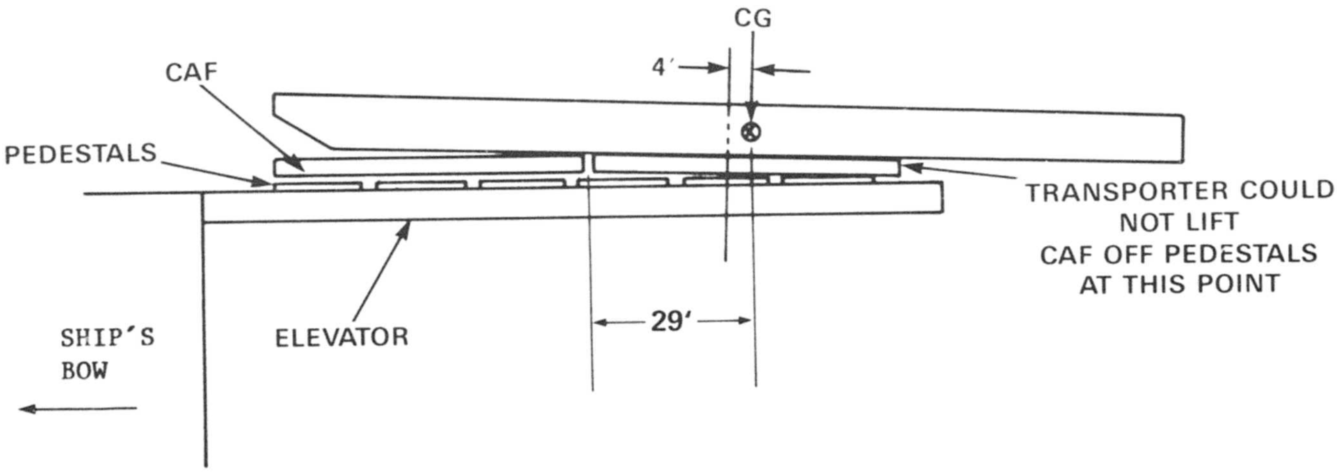


Figure 19 - Incomplete Lift of TCDF When
Loaded onto Ship Bow-First

Second Lift. The TCDF was lowered back into the water, reversed to a stern-first entry, and again lifted to the upper deck. Figure 20 shows the small clearance between the TCDF stern and the mate's platform over the transom. This time the transporters were able to accomplish full lift-off of the CAF's from the elevator pedestals, as illustrated in Figure 21, and to synchronously transit the deck to the stowage position aft of the LARCs'.

Figure 20 - Clearance between TCDF on Elevator's
and Ship's Transom during Liftout

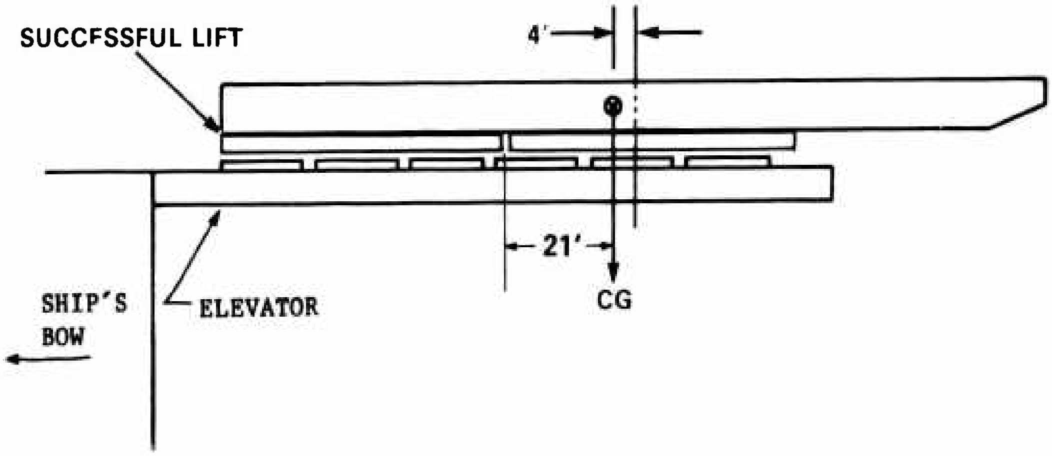


Figure 21 - Successful Lift of TCDF When Loaded Stern-First on Elevator

A third pair of CAF's was retrieved from the main deck and positioned (shipwise) aft of the TCDF. The TCDF was then shifted aft so that its 150-ft length was completely supported on six CAF's. This is illustrated in Figure 22.

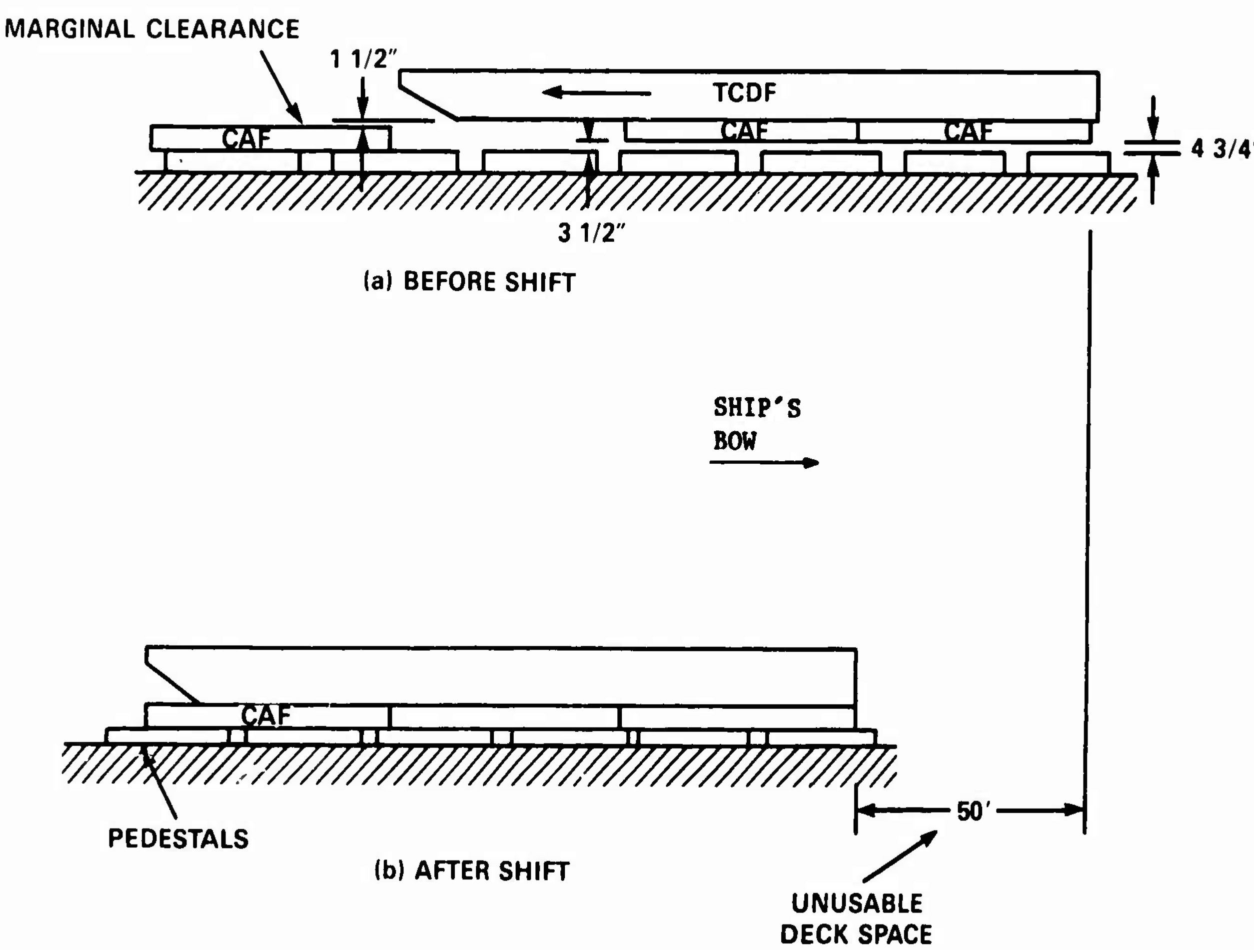
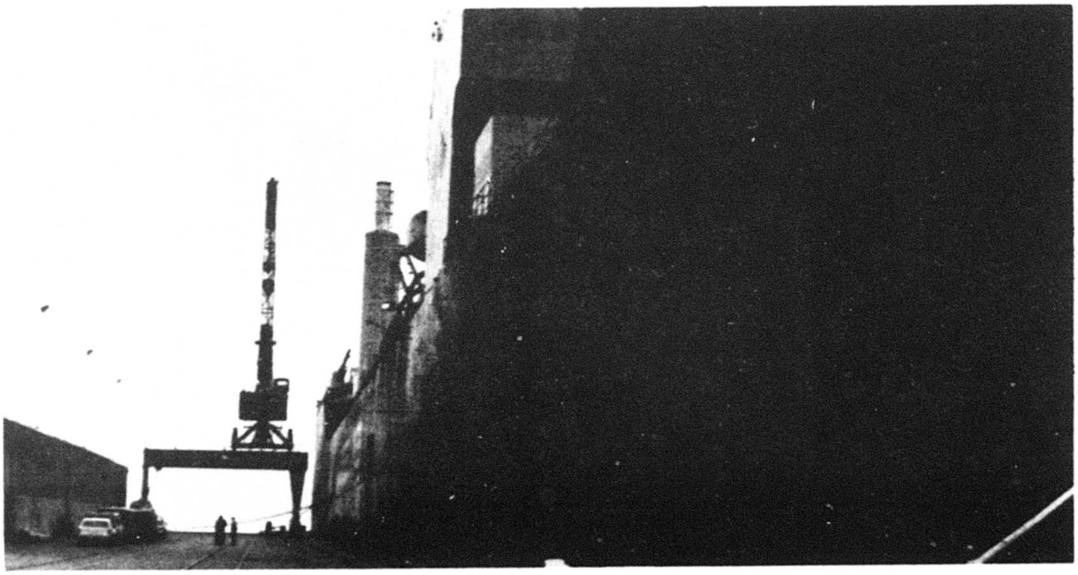
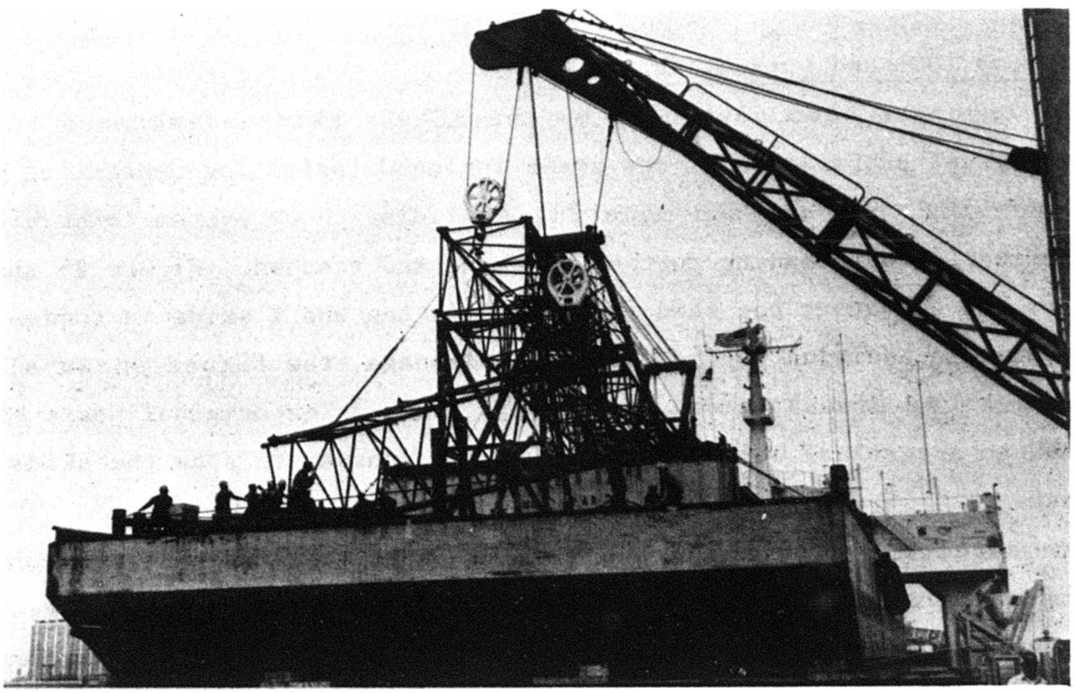


Figure 22 - Procedure Used to Install Third Pair of CAF's under TCDF

Because of the reversed orientation of the TCDF, the disassembled boom sections had to be relocated from the bow to the stern of the barge (shipwise forward) in preparation for boom reassembly. The disassembled boom sections were shifted using a mobile crane on the adjacent pier as shown in Figure 23. Figure 24 shows the sections relocated on the stern at the TCDF barge.



(a)



(b)

Figure 23 - Mobile Pier Crane Used to Shift TCDF Boom Sections from Bow-to-Stern of Barge

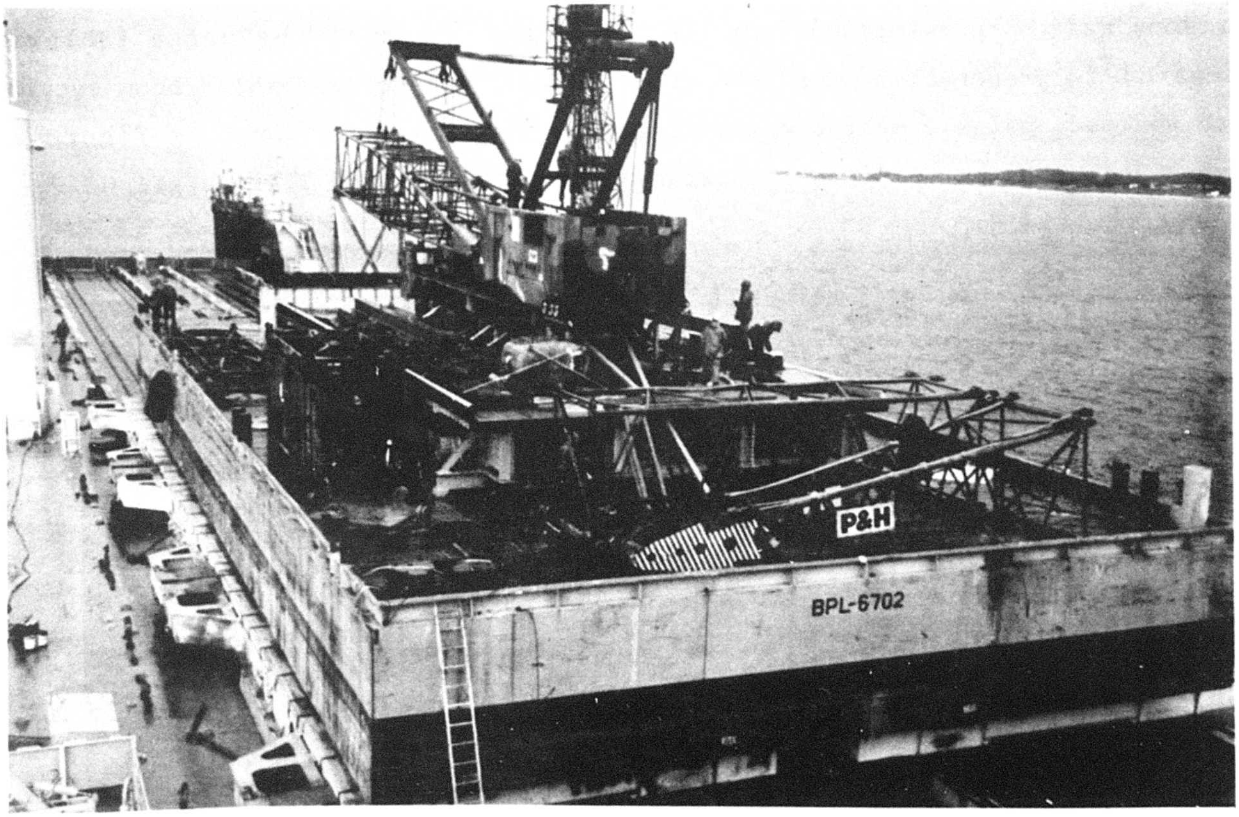


Figure 24 - TCDF Boom Sections Relocated on Stern of Barge

Lift 4: Army 100- and 65-Foot Tugs

The tugboats were supported by the SEABEE skids, described in Section 2.1.2. Pretest preparation of the skids included installing centerline dunnage for supporting the keel and mounting a sliding chock system to stabilize the craft during liftout pending further blocking and tiedown. Figure 25 shows the skids on the elevator; one skid for the 65-ft tug and 2 skids in tandem for the 100-ft tug. In addition to the chocks and dunnage, the figure shows alignment posts (vertical pipes) welded to the skid beams. The original posts had to be shortened to a vertical height of about 10 ft in order to stow the skids on the main deck.

The concept was to align the two tugs over their respective skids, using the alignment posts for accurate positioning, raise the elevator until the keel was grounded, then have divers slide the chocks over greased surfaces into contact with the hull and secure them in position by screwing "set-screw" bolts into contact with the skid beams.

Before the tug loading operation began, the ship ballasted aft to accommodate the stern trim of the tugs, and to preclude damage to their lower rudder

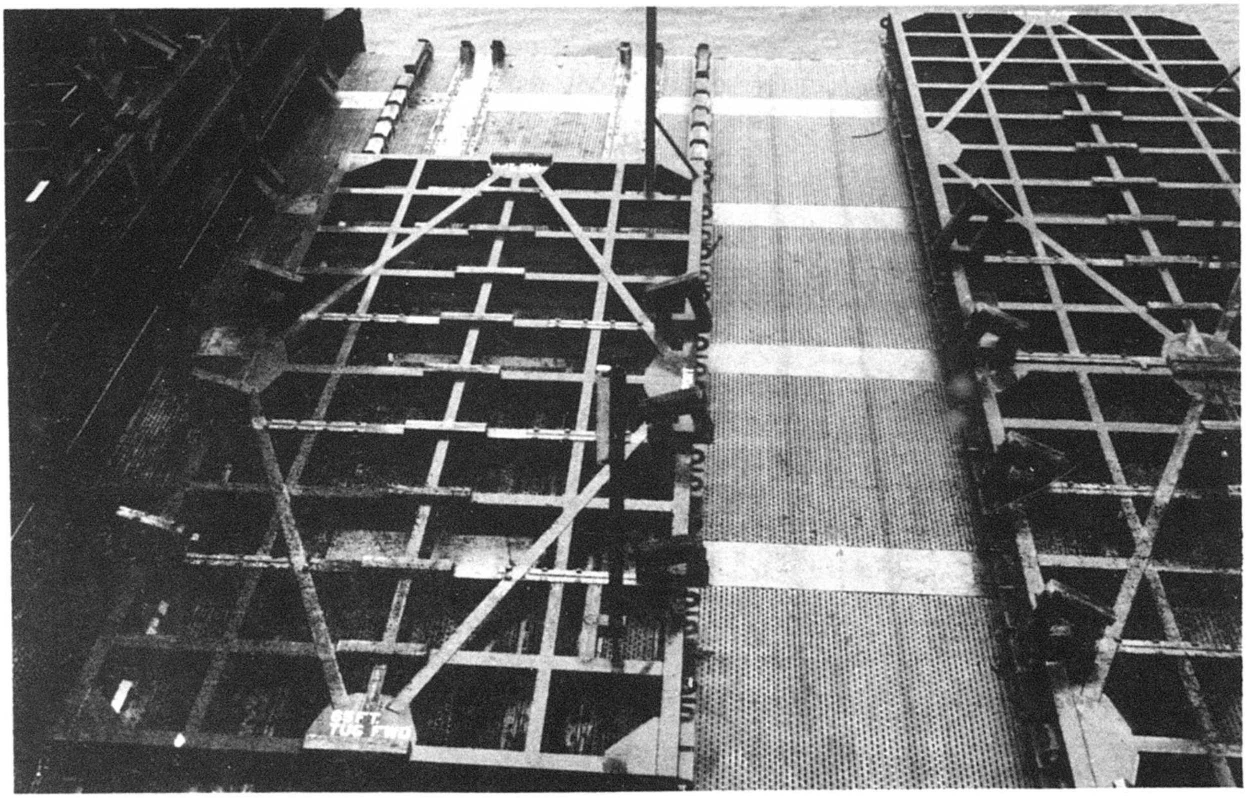


Figure 25 - SEABEE Skids Positioned on Elevator
(Note alignment posts projecting up from 65-foot tug skid)

post bearings in the event they contacted the skid first in the process of seating the full length of the keel on the dunnage.

The elevator was submerged to a depth of about 20 ft (about the lower limit of elevator travel) to lower the chocks below the draft of the tugs and, as a result, the alignment posts were submerged.

The 100-ft tug was directed into the port side of the well, but the current drifted it starboard into the submerged alignment posts of the 65-ft tug skid. The securing of lines and alignment of this tug required significant time as noted in the Analysis section. The 65-ft tug entered the starboard slot utilizing the current to hold it against the ship's starboard rub rails as a guide.

The tugs were aligned over their respective skids and the elevator was raised until the 100-ft tug keel was fully grounded out. Divers inserted and secured the chocks, then the elevator was raised further to ground the keel of the 65-ft tug and its chocks were inserted. The tugs were then elevated to the main deck level for inspection.

As discussed in the Analysis section, the chocks for the 100-ft tug appeared deformed and in a state of failure so the liftout was halted and the system was reinforced which required about 9 hr. When completed, the lift continued to the upper deck and the tugs were transported to their stowage position aft of the TCDF and chained to the ship's deck as seen in Figure 26. The addition of chocks and tiedowns was accomplished by ship's crew and their supporting subcontracts.

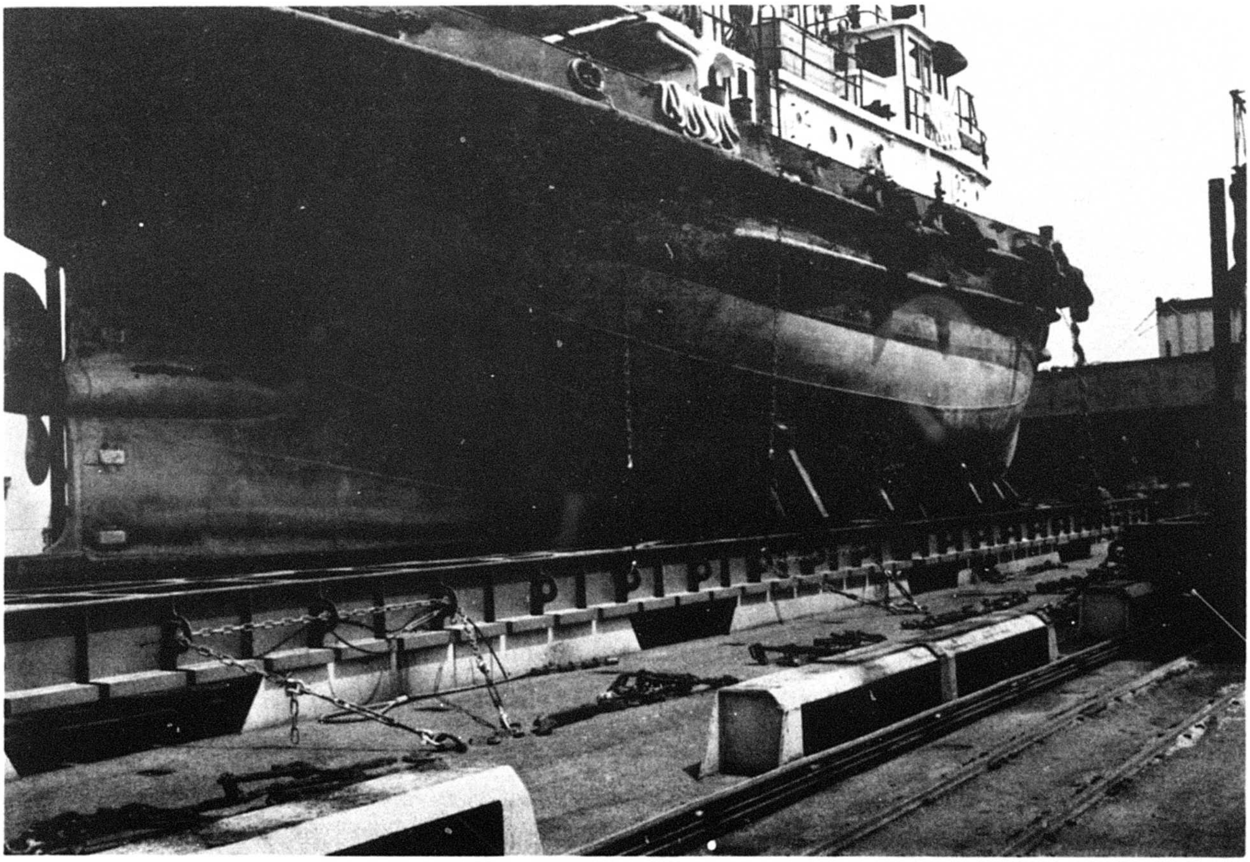


Figure 26 - 100-Foot Army Tug Stowed on SEABEE Deck
(Tug is lashed to skid and skid is lashed to ship's deck)

Lift 5: Landing Craft, Utility (LCU's)

Two modified CAF's were placed in tandem on both the port and starboard sides of the elevator as seen in Figure 27. They were each fitted with 4 in. x 4 in. I-beam sections. The LCU liftout operation was delayed while the bare I-beams were capped with dunnage to protect against damage to the craft bottom plating.

The 1466 Class LCU, ATLANTA, entered stern-first into the port (up-current) side of the elevator well followed by the 1667 Class LCU, DOUBLE EAGLE, into the starboard side. As before, positioning lines and breast lines were secured as

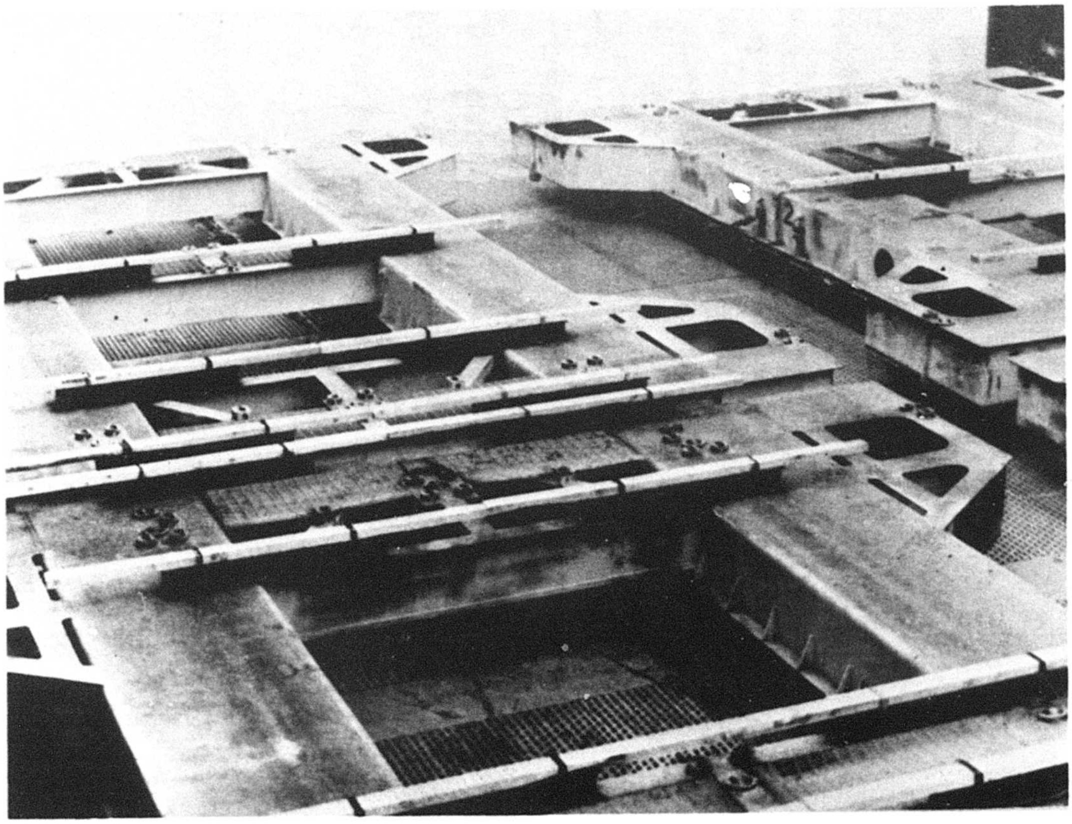


Figure 27 - LCU CAF's on SEABEE Elevator

shown in Figure 28 and the craft were aligned over the CAF's using the paint markings. Figure 29 shows the small clearance between their sterns and the ship's transom.

It was originally planned to load the LCU's bow-first and the dunnage on the CAF's was set up accordingly. Subsequently, it was realized that the sterns of the 1466 and 1667 Class LCU's would overhang the 100-ft CAF's by 15 ft and 35 ft respectively. Since the propulsion machinery of the craft is located in the stern, there was concern over the unsupported after structures. The plan was then changed to a stern-first loading of the LCU's, but without considering reversing the CAF dunnage pattern.

When the LCU's were lifted to the main deck, the propulsors were resting on dunnage intended for the bow and the bow remained unsupported. Additional dunnage was then wedged under the bows and the liftout continued.

The LCU's were stowed on the upper deck aft of the tugs. This completed the ship loading portion of the SEABEE Deployment Test.

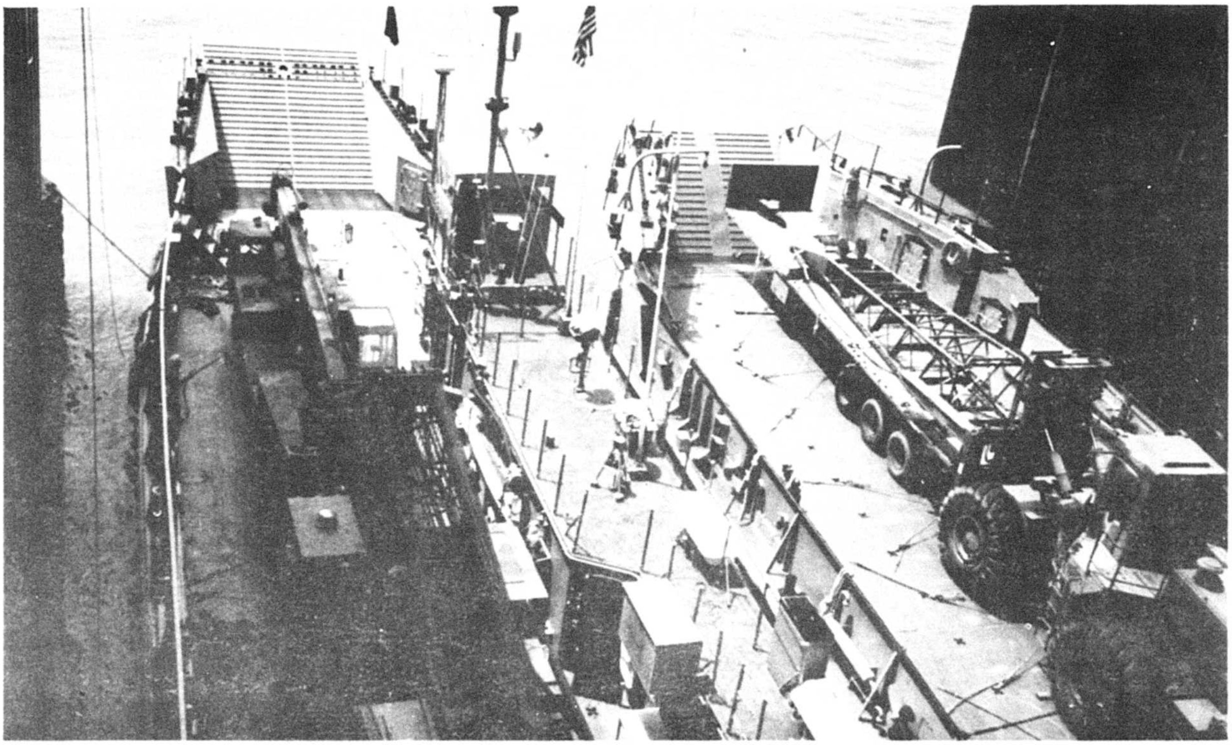


Figure 28 - LCU's Positioned Over CAF's in SEABEE Well

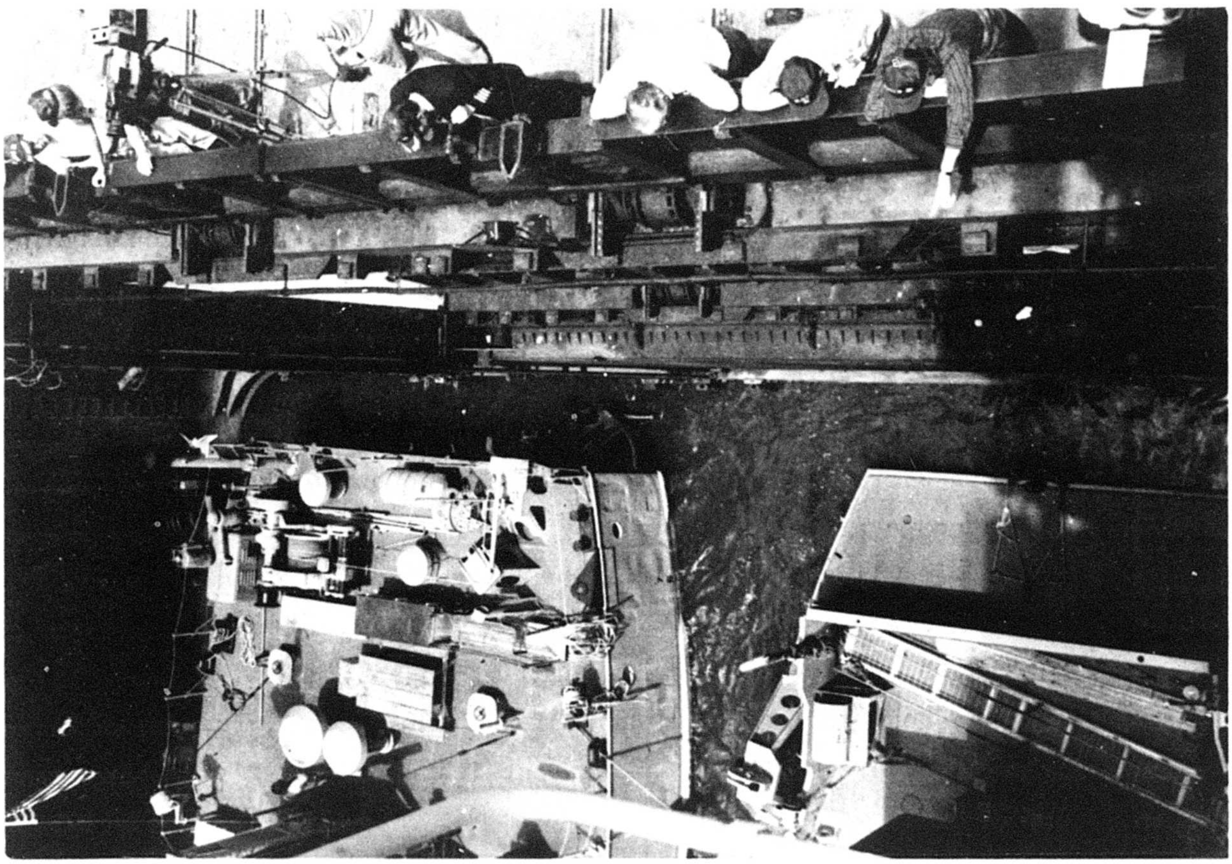


Figure 29 - Small Clearance between LCU Transoms and SEABEE Transom

2.3.3 SEABEE SHIP OFFLOAD

Upon completion of the loadout, the ship was repositioned from the Newport News Marine Terminal to an anchorage approximately one mile off, Fort Story, Virginia to commence the offloading test. The operations began on 7 May with the offload of the LCU's.

In general, the offload procedure for each test article was:

- Position transporter under the stowed load.
- Transport load onto the elevator and secure adaptor frames to elevator pedestals.
- Lower elevator to main deck and remove transporters.
- Lower elevator until adaptor frames are partly submerged to allow flooding.
- Continue to lower elevator until load floats free.
- Cast off lines, load exits well.
- Return elevator to main deck level, unlash and remove empty adaptor frames, stow in main deck.
- Return elevator and transporters to upper deck and start next offload cycle.

2.3.3.1 ORDER OF SEABEE OFFLOAD

The order of the offload was the reverse of that listed in Section 2.3.2.1.

2.3.3.2 SPECIFIC OFFLOADING PROCEDURES FOR EACH TEST ITEM

Lift 1: LCU'S

The LCU's were launched in accordance with the above general procedure and without incident. Figure 30 shows the craft departing the well simultaneously after achieving floatation, starting their engines, and casting off lines.

Lift 2: 100- and 65-Foot Tug Boats

The tugs were unlashed from the ship, transported to the elevator, and lowered to the main deck where the crew embarked up a Jacob's ladder and released the chain tiedowns to the skids. Bow lines were led forward from the tugs and secured to the main deck to prevent the craft from drifting aft in the well in the event flotation was achieved prior to starting and warming up the engines.

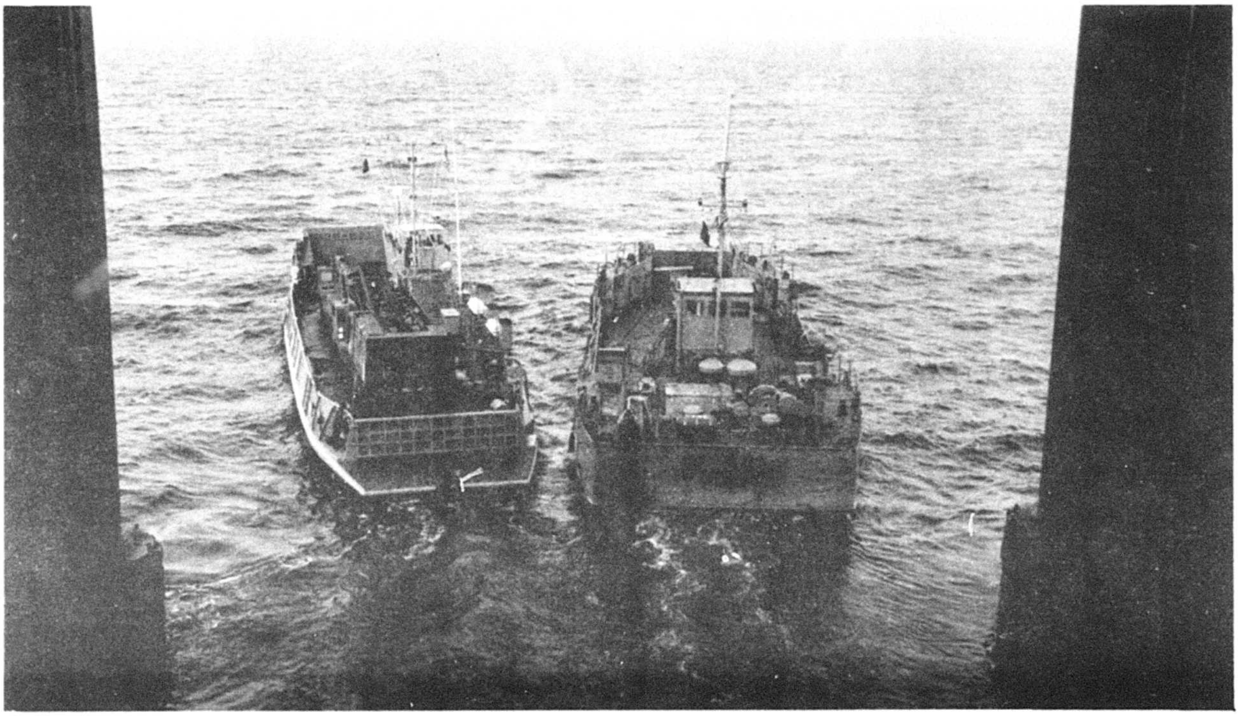


Figure 30 - LCU's Departing SEABEE Well

The tugs were lowered until their bilges were wetted above their cooling water intakes. The diesels were started and, after a short warm up period, the elevator continued down until the 65-ft tug floated free of its skid and backed out of the well. When the smaller tug cleared the ship, the elevator proceeded down until the 100-ft tug (with deeper draft) floated and backed out.

Lift 3: TCDF

The test plan called for the TCDF crane boom to be reassembled prior to launch, utilizing the mobile cranes brought aboard in the LARC LX's. The TCDF was unstowed and transported to the elevator in the reverse of the process performed during loadout.

The TCDF crane was unlashed and rotated 180 deg so that it faced (shipwise) forward, and the elevator was lowered so that the extended horizontal boom section rested on blocks on the upper deck. The truck cranes were disembarked from the LARCs' (Figure 31) and positioned forward of the TCDF for the boom assembly operation shown in Figure 32. Figure 33 is a view from the ship's bridge showing the assembled boom facing shipwise forward and elevated to eliminate interference with the ship as the elevator lowered the TCDF into the water. Figure 34 shows the Army tugs extracting the TCDF from the well to

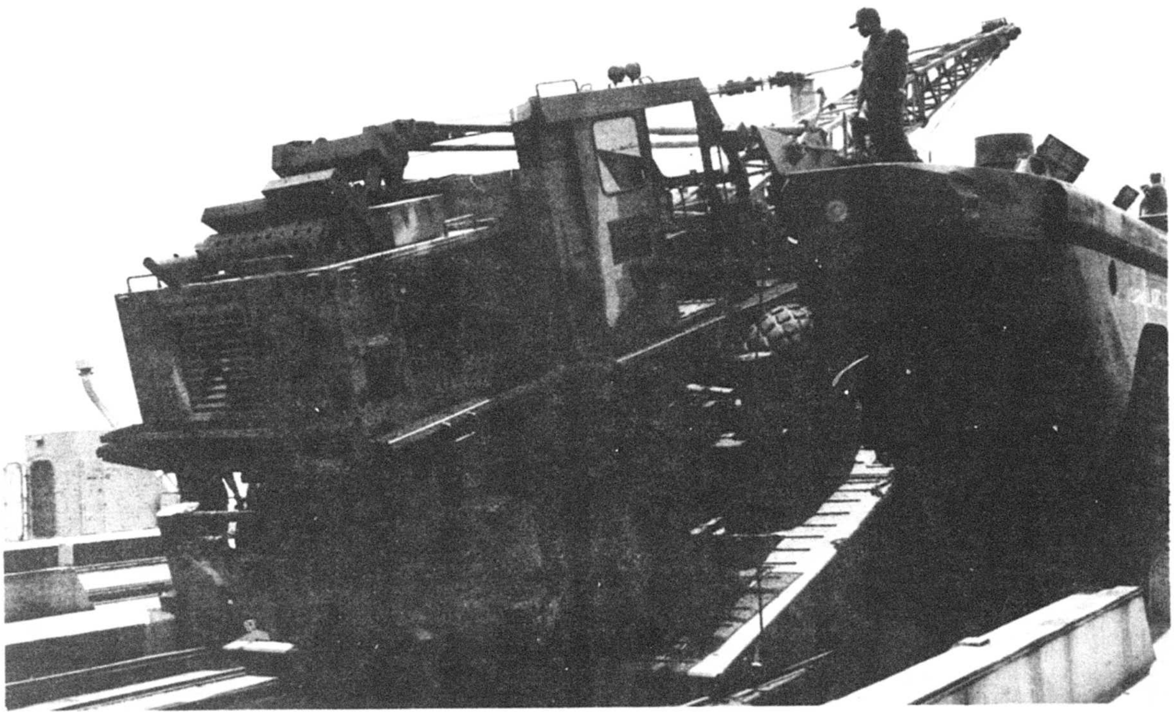


Figure 31 - Crane Disembarking from LARC

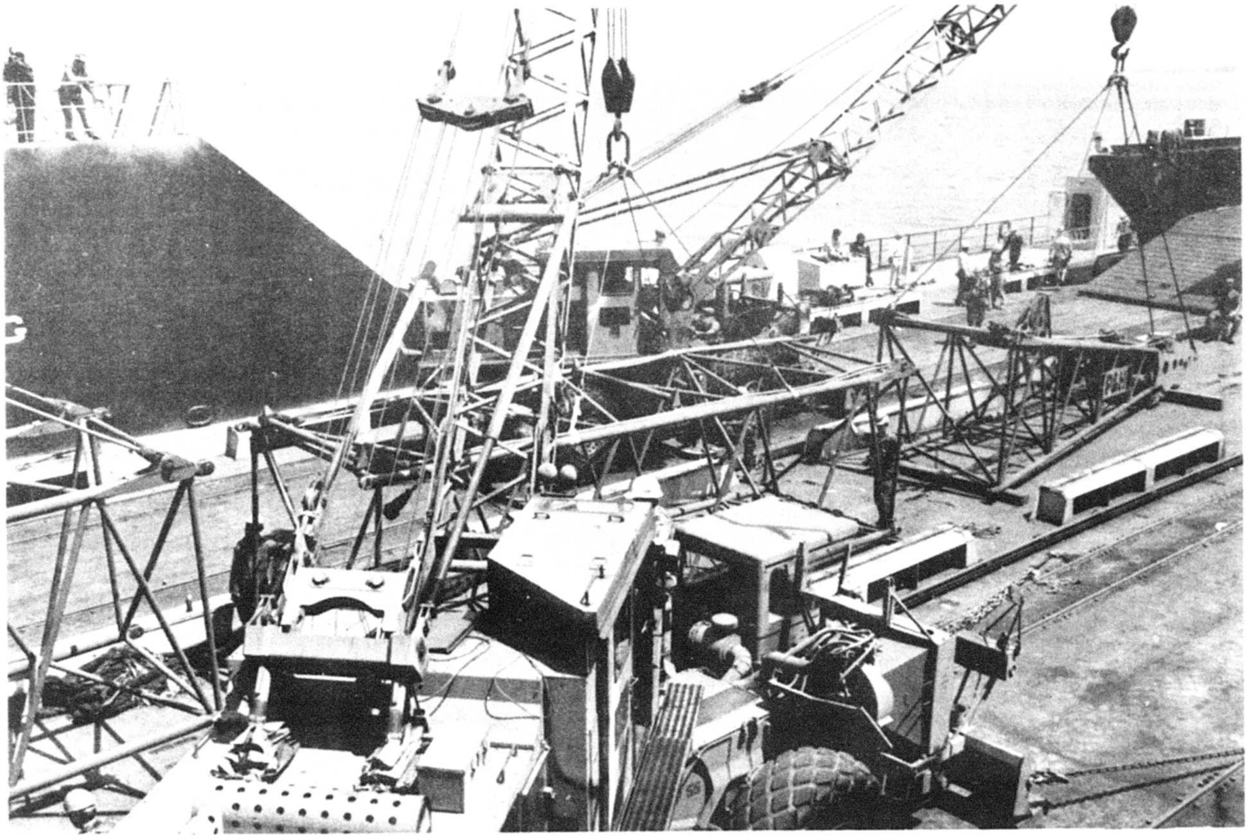


Figure 32 - Truck Cranes in the Assembly of the TCDF Boom (TCDF is on partially lowered elevator so that its boom projects parallel to the deck, supported on wooden blocks.)

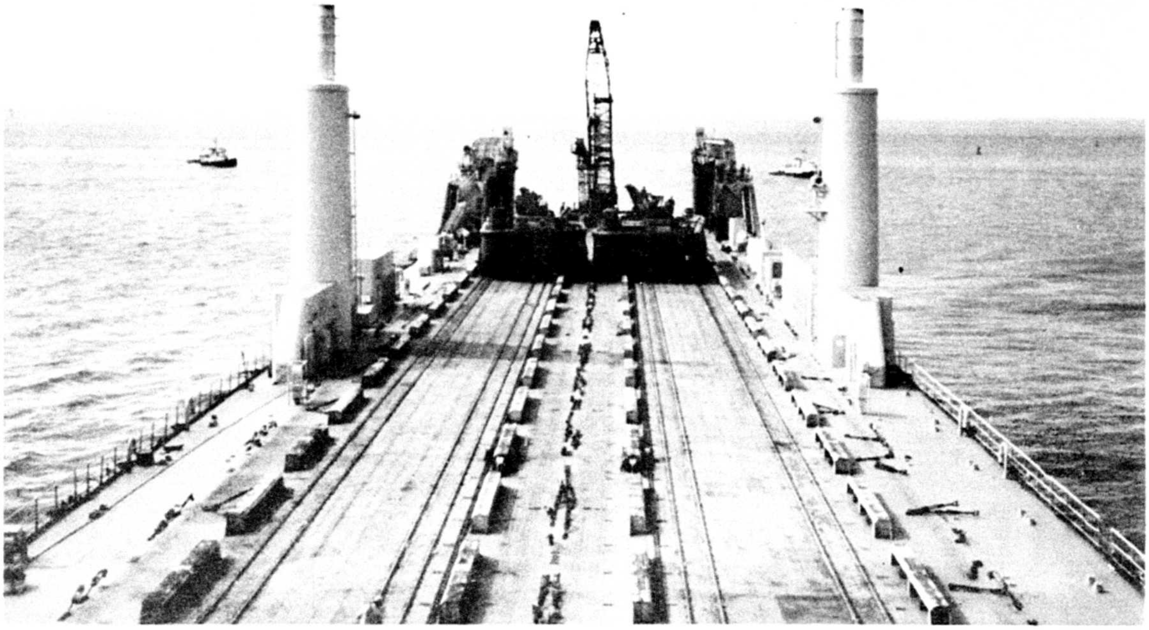


Figure 33 - TCDF on Elevator after Boom Assembly
(as seen from Bridge of SEABEE ship)

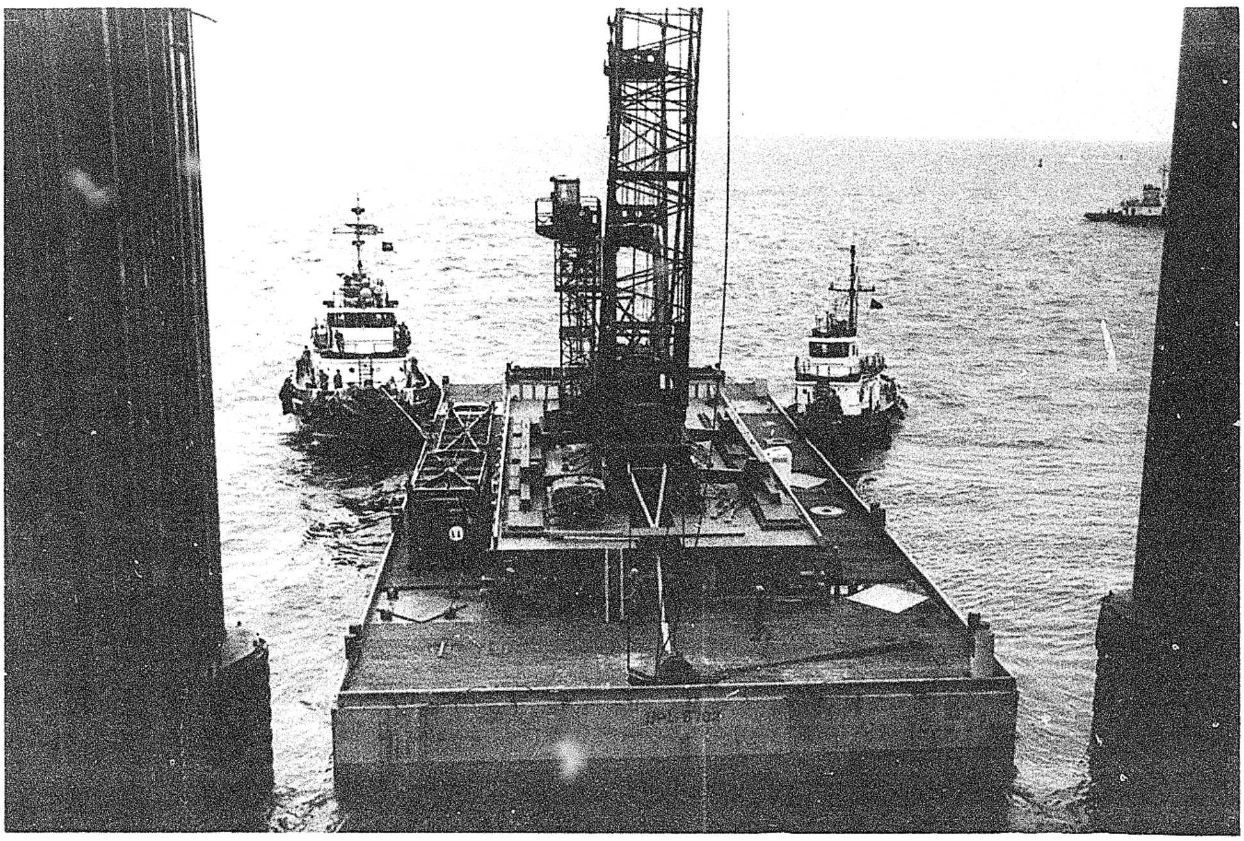


Figure 34 - TCDF Being Withdrawn from SEABEE Well
by 65- and 100-Foot Army Tugs

complete the TCDF operation. Figure 35 shows the empty TCDF CAF's being stowed in the main deck in preparation for launching the LARCs'. Boom assembly was conducted by Army TCDF personnel.

Lift 4: LARC LX's

Upon completion of the assembly of the TCDF boom, the mobile cranes reembarked aboard the LARCs'. The LARC's transited to the elevator, were lowered into the water and exited the well simultaneously as shown in Figure 36.

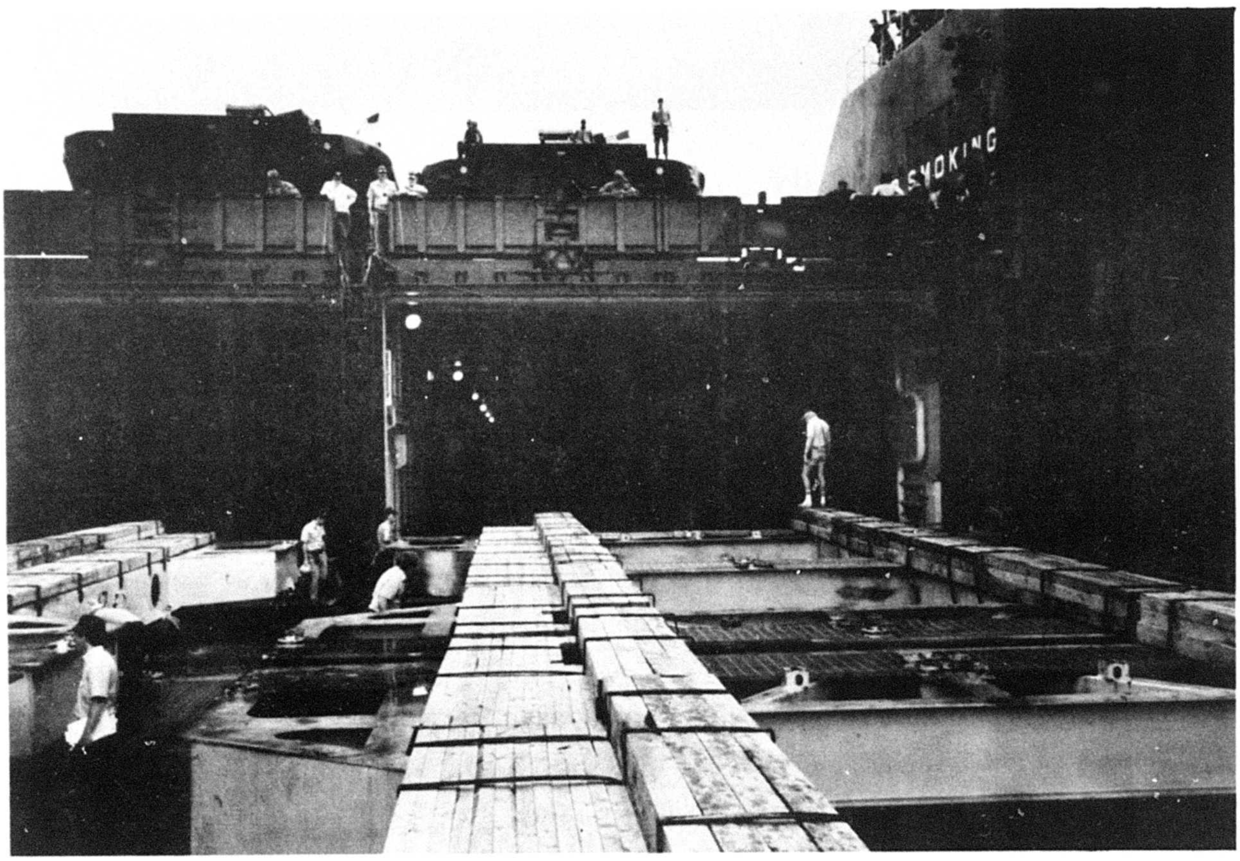


Figure 35 - Empty TCDF CAF's Being Stowed
in SEABEE Main Deck after TDCF Launch

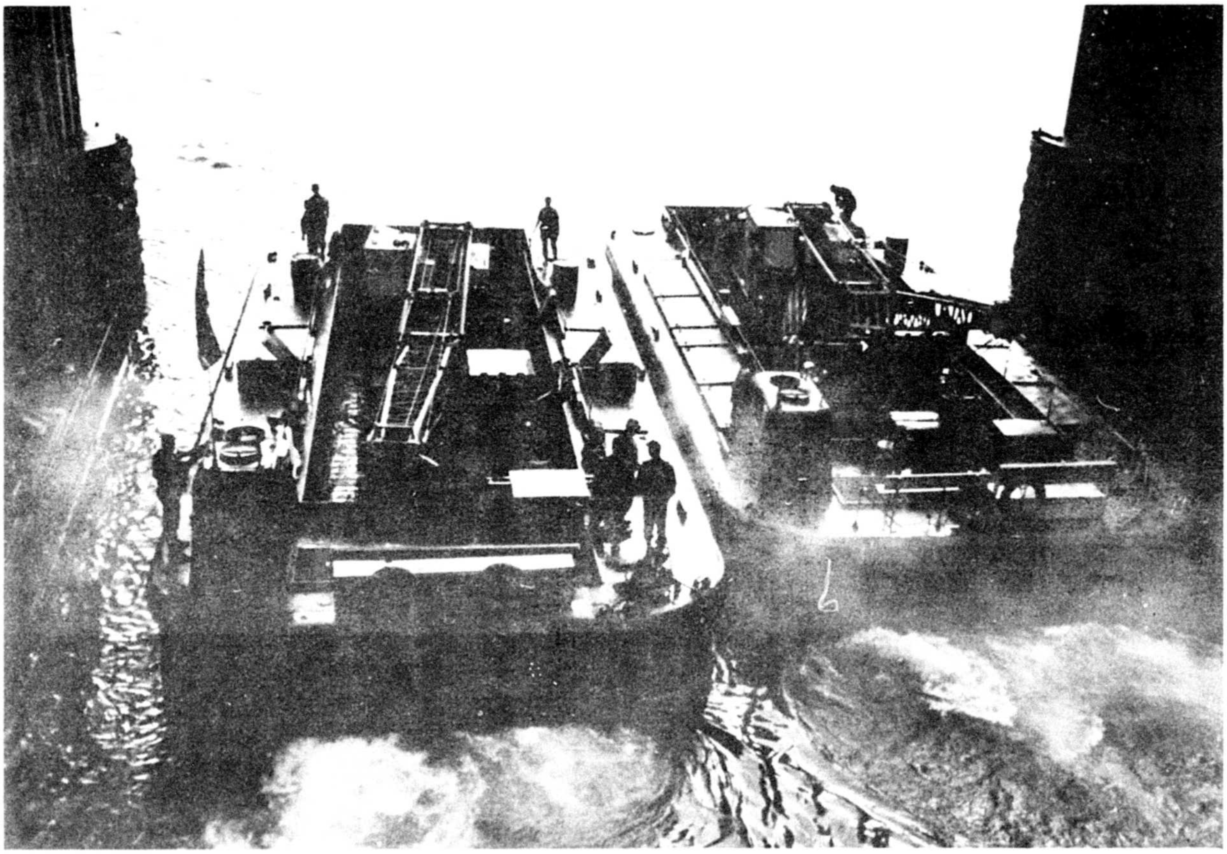


Figure 36 - LARC-LX's Exiting SEABEE Well after Being Launched

Lift 5: LACV-30

The LACV-30 offload was halted temporarily by a passing squall line. Afterward, the craft was placed on the elevator, as shown in Figure 37 (note the wet deck from passing storm), and lowered to a position just above the water to allow engines to be started and warmed up. The craft was launched, completing the SEABEE Deployment Test.

Because of deteriorating weather, the Cube Barge launch was cancelled and it was discharged the following day at the Newport News Marine Terminal.

2.3.4 SUMMARY OF ENVIRONMENTAL CONDITIONS DURING SEABEE TEST

Weather, sea conditions, and ship motions were obtained by visual observations throughout the SEABEE loading period and are tabulated in Table 3. During the SEABEE offloading operation, the ship's anemometer, air temperature gauge, compass, and roll and pitch inclinometers were read approximately every hour and when unusual weather conditions were encountered. This data, along with other visually observed conditions, is summarized in Table 4.

Figure 37 - LACV-30 Being Transported to Elevator during Launch Procedure

TABLE 3 - SUMMARY OF ENVIRONMENTAL CONDITIONS DURING SEABEE LOADING

	TEST DATES 5-7 MAY 1984		
	5th	6th	7th
Wind - Speed (kts)	0-10	0-10	0-5
Temperature Air deg F.	70-82	68-73	73-74
Precipitation	Dry	Occasional Showers	Dry
Visibility	Clear/Sunny	Partly Cloudy	Partly Cloudy
Wave - Significant Hgt (ft)	0-1	0-2	0-1/2
*Current (kts)	0-1 1/2	0-1	0-1/4
Ship Motion	None	None	None

*The ship's stern projected beyond the pier into the river and the current swept across it's elevator well entrance.

TABLE 4 - SUMMARY OF ENVIRONMENTAL CONDITIONS DURING SEABEE OFFLOADING OPERATIONS

DATE	7 MAY	8 MAY					
TEST EVENT	LCU's Launched	Tugs Launched	TCDF-Crane Boom Assembly	TCDF Launch	LARC's Launched	Storm Delay	LAC(V)30 Launch
TIME OF DAY	1900	0830	1330	1700	1830	1900	2015
Wind - Speed (kts)	10-15	13-17	22-26	22-28	17-20	34-65*	25-65*
- Direction	NE	SSW	SW	SW	SW	SW	SW
Temperature Air - deg F.	68	67	76	80	75	73	69
Precipitation	Dry	Heavy Rain	Dry	Dry	Dry	Heavy Rain	Heavy Rain
Visibility	Clear/Sunny	Cloudy	Clear/Sunny	Clear/Sunny	Cloudy	Storm Clouds	Thunder Storm/ Darkness
Wave - Significant Hgt (ft)	2-3	2-3	2-3	2-3	1-2	4-5	2-3
- Direction From	NE	SW	SW	SW	SW	SW	SW
Current E-Ebb, F-Flood (kts)	1E	1E	1/2F	0	3/4E	1E	1 1/4E
Ship Motion/Heading							
- Roll (deg)	0	0	0-1	0-1	0-1	0-1	0-1
- Pitch (deg)	0	0	0	0	0	0-1	0
- Heading (deg)	300	250	160	200	270	310	290

*Recorded during passage of an afternoon squall.

2.4 DISCUSSION AND ANALYSIS OF SEABEE TEST

2.4.1 SHIP LOADOUT

Equipment, procedures, personnel, time, and environmental impacts are discussed for ship loadout.

2.4.1.1 EQUIPMENT

Test cargo, support equipment, and ship equipment are treated in that order.

2.4.1.1.1 TEST CARGO

Each test cargo item entered the SEABEE elevator well under its own power except for the TCDF which was guided in by the Army tugs. Each lift, except for the TCDF, included two cargo items as listed in Table 2, Section 2.3.2.1. The task of entering the well and holding position while passing lines was complicated by a current across the ship's stern and across the well. Some craft appeared more suitable (operating characteristics) than others to maneuver sideways against the current. For example, the Cube Barge, LACV-30, and Landing Craft, Utility (LCU's) have powerful propulsors arranged in a wide stance and each demonstrated good control. On the other hand, the LARC-LX's and especially the Army tugs (single screw) had difficulty holding position while lines were passed and secured.

The individual craft characteristics were not totally responsible for the difficulties observed in maneuvering in the well. The lack of procedures and the lack of operator skills/experience were the variables which degraded the efficiency of the shiploading operation. For example, tugboats are designed to be very maneuverable when attached to a load, especially when working in pairs. However, Figure 38 shows the difficulty the two Army tugs had while pushing the TCDF into the well with a cross current.

Because of the procedure developed by the Army for assembly of the TCDF boom during the offload, there is a requirement for specific equipment to be loaded in a specified order. Therefore, the TCDF deployment package includes two LARC-LX's, each carrying a 20-ton mobile crane. The LARC-LX's must be ship-loaded immediately forward of the TCDF with their ramps facing shipwise aft so the cranes can disembark into the boom assembly area.

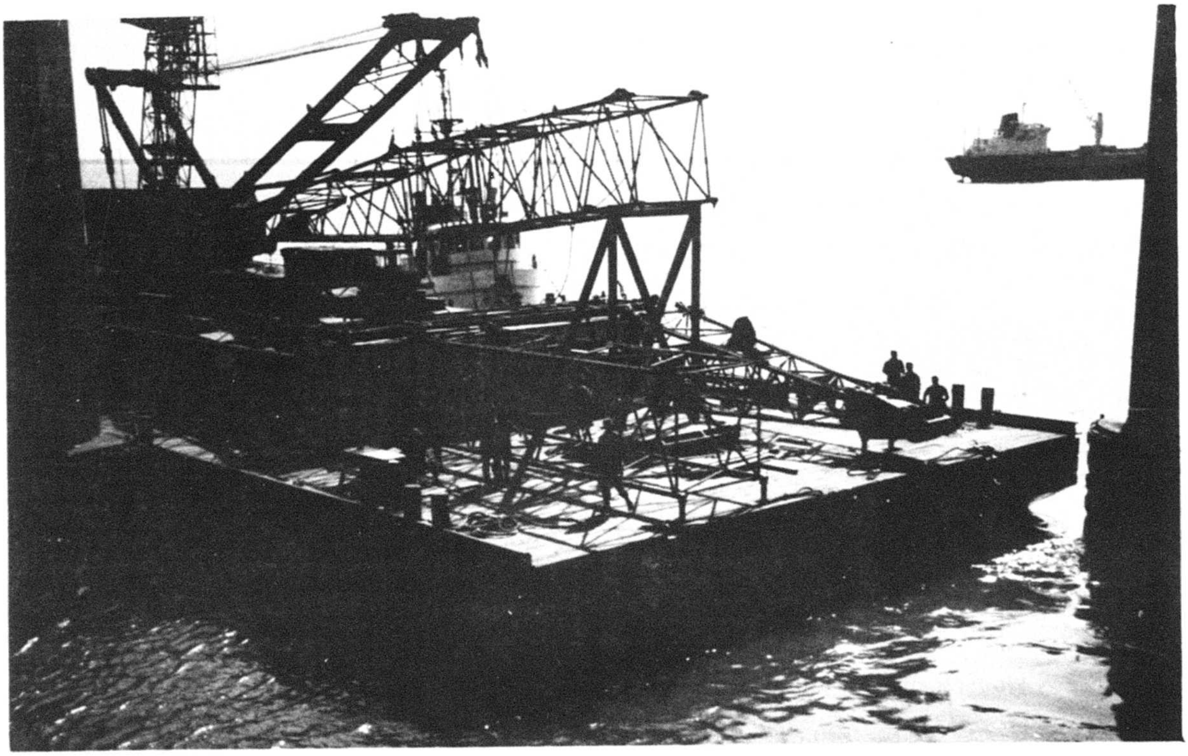


Figure 38 - TCDF Drifting with Strong Current during Onload of SEABEE Ship

As noted in Section 2.3.2, the LACV-30 was to be lashed for storm sea conditions as a test demonstration. An examination of craft tie-down fittings, however, caused some doubt about the structural feasibility of applying heavy securing loads to specified points on the craft. Therefore, lashings were applied, but left slack. A reevaluation of the craft tiedown configuration is required.

With reference to Figure 39, for the ship's positioning lines to be effective, they must be secured at angles which result in fore and aft and transverse alignment forces. The craft did not all have appropriately placed chocks or fair leads to allow for an effective hook up to these lines. The addition of such chocks/fair leads should be in the operating plan for future deployments.

2.4.1.1.2 SUPPORT EQUIPMENT

The principal interface items were the CAF's and SEABEE skids. These basic items proved ideally suited for this purpose since they were designed to be handled by the SEABEE ship's barge transporter and to be stowed on the deck pedestals normally used by the SEABEE barges in commercial operations. All test

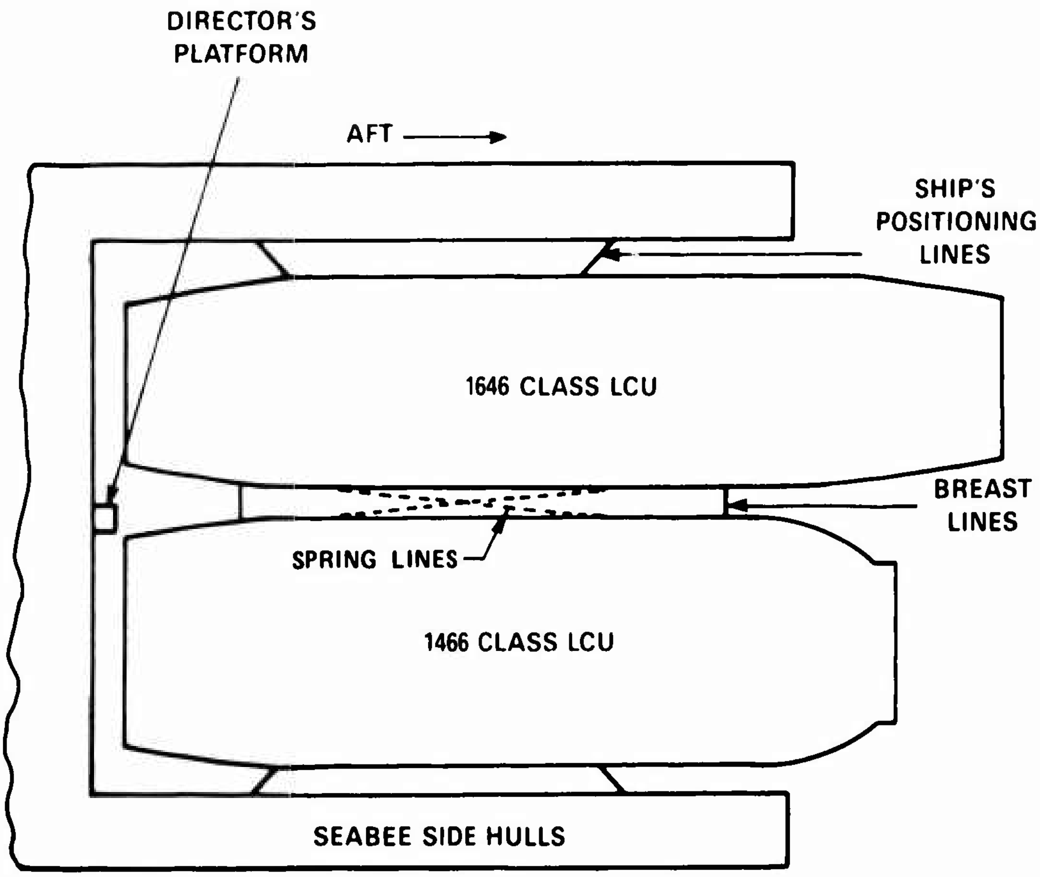


Figure 39 - Proper Hookup of Positioning Lines, Spring Lines, and Breast Lines

cargo items, except the amphibious LARC-LX's, were brought aboard by landing them on CAF's or SEABEE skids secured to the elevator and which had been modified to support the specific configurations of their intended loads. The modifications included the addition of chocks, dunnage, and steel plates to support the loads and to protect them from contacting the array of container corner sockets projecting from the surface of the CAF's. The modifications were performed aboard ship prior to the cargo loading test.

The modifications to the CAF's and skids were not totally adequate or satisfactory. Modifications to the Cube Barge CAF were the simplest, involving two longitudinal rows of single layer wood dunnage. However, since there are no transverse strength members in the Cube Barge, two rows of dunnage are not considered adequate to support the craft when subjected to dynamic forces normally experienced during loading and transit operations. Adding a centerline row of dunnage or, better still, covering the entire CAF surface with dunnage would be more appropriate.

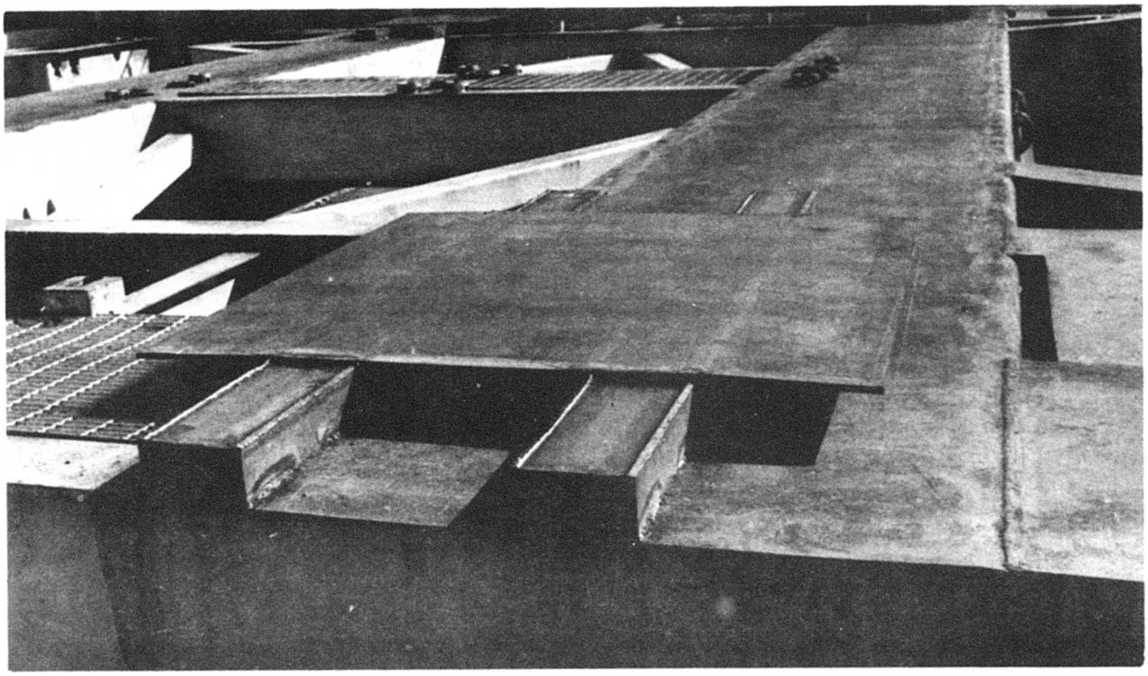


Figure 40 - CAF Modifications to Support LACV-30

The CAF modification for the LACV-30, seen in Figure 40 provided adequate support, although it required rather precise positioning of the craft. The pad areas could be increased to relax the alignment requirement. Also, since the LACV-30 landing pads are faced with a fairly smooth plastic material, there is a possibility that they could slip on the smooth steel surface of the modified CAF, especially if the surfaces are wet as they will be when the craft is first brought aboard the ship. A more suitable material, e.g., wood which has a higher coefficient of friction when wet, should be considered along with chocking or fencing around the pads during ship transit.

There was excess wood dunnage on the TCDF CAF's shown in Figure 41 and 42. It is important to provide at least eight inches of dunnage in order to assure clearance for the outboard skegs of the TCDF hull, but there is no requirement for the dunnage that existed under the barge skegs since there was no contact made with this dunnage.

The modifications of the SEABEE skids (seen in Figure 25, Section 2.3.2.2) was inadequate, not only in terms of the requirements for restraining the tugboats in ocean transit, but even for the tranquil conditions of the test. It is recognized that the purpose of the hull chocks added to the skids is for stabilizing the tugs during the onload and offload portions of the operation and that an appropriate lashing scheme should provide the primary support during

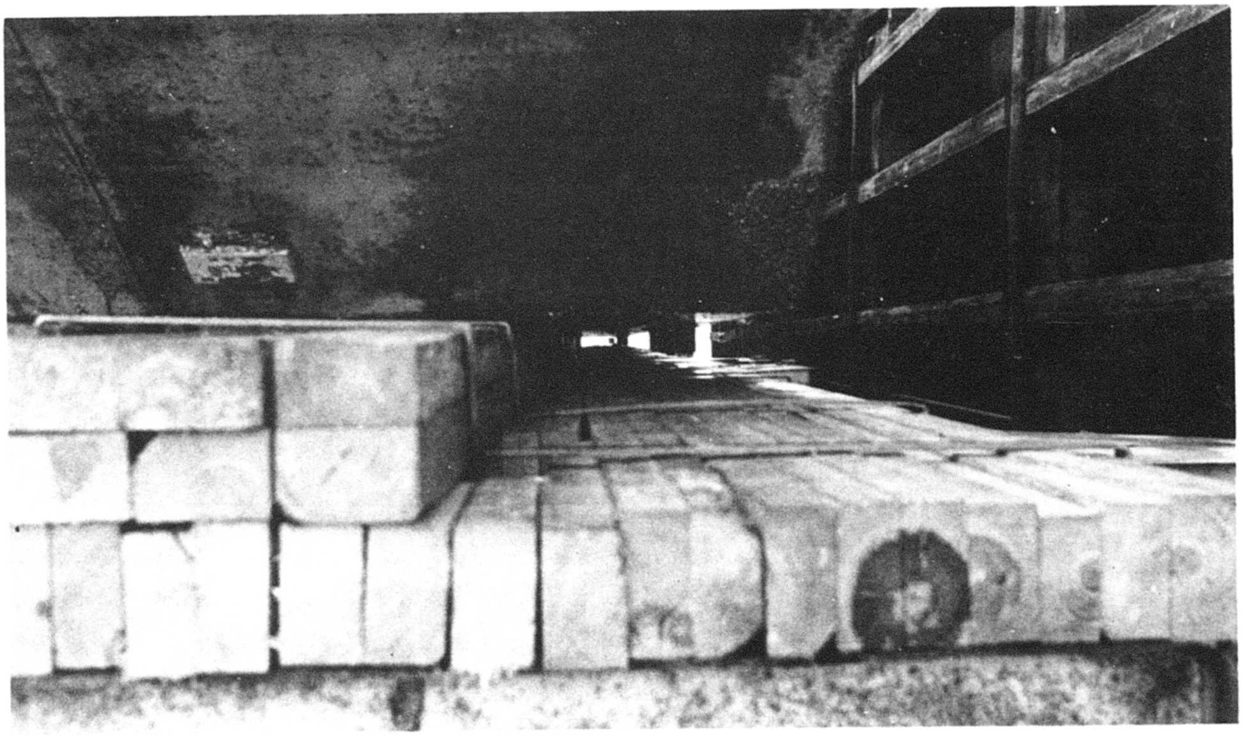


Figure 41 - Dunnage on TCDF CAF

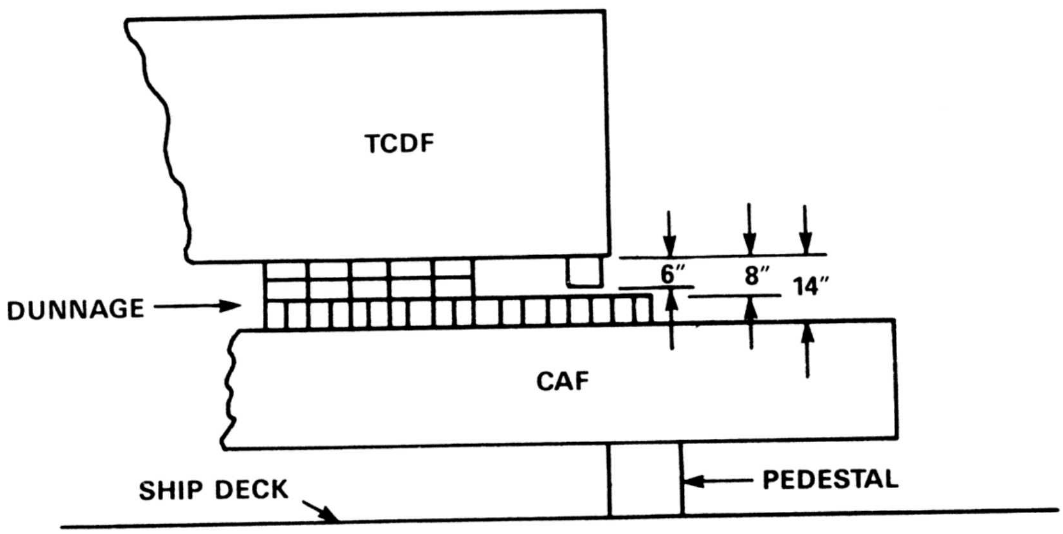


Figure 42 - TCDF Dunnage Pattern
(Bottom level of timbers are not necessary and could be unstable)

transit. However, the yielding of the 1/4-in. webs of the I-beam section of the chocks and the weld failures of the set screw attachments holding the chocks in place, confirms the design inadequacy.

The suspected mechanism causing the chock overload, which should be considered in future restraining system designs, was the sag of the tug hull as buoyancy was lost during liftout and the total weight of the craft settled onto its keel. This is depicted in Figure 43. Downward deflection of the tug's bilges caused the wooden faces of the I-beam chocks to rotate flat against the hull surface, resulting in bending of the webs and twisting of the chocks on the greased skid beams as shown in Figure 44.

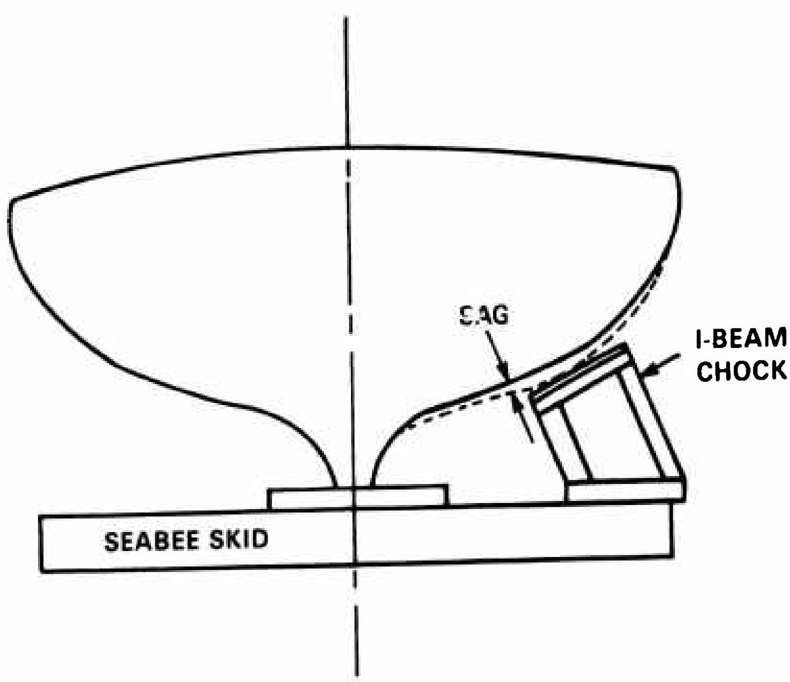
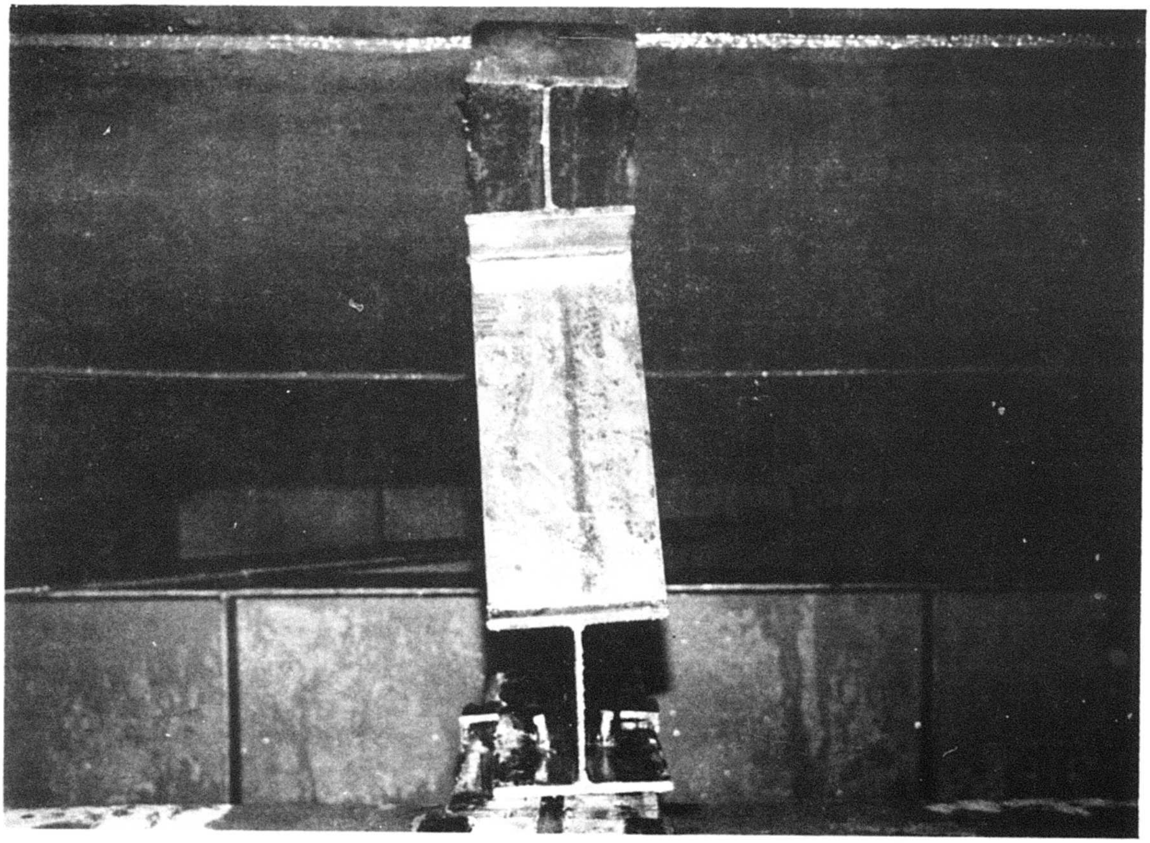
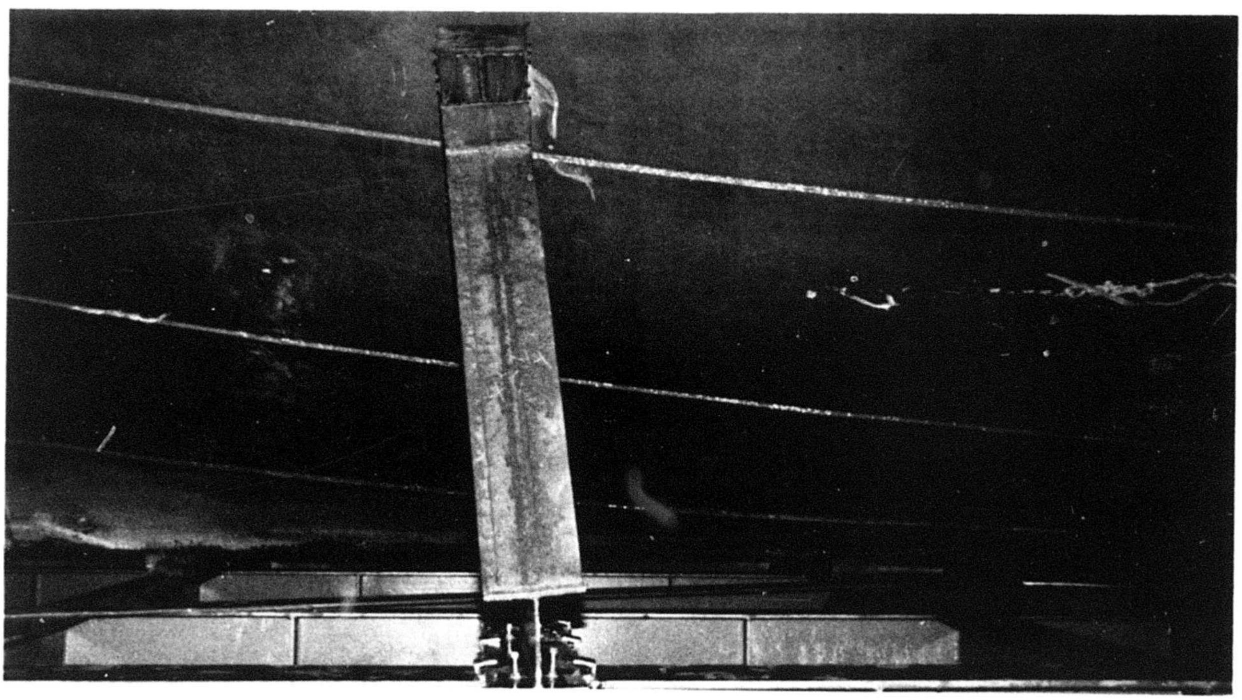


Figure 43 - Sag of Bilge When Weight Rested on Keel
Is Suspected Cause of Chock Failure



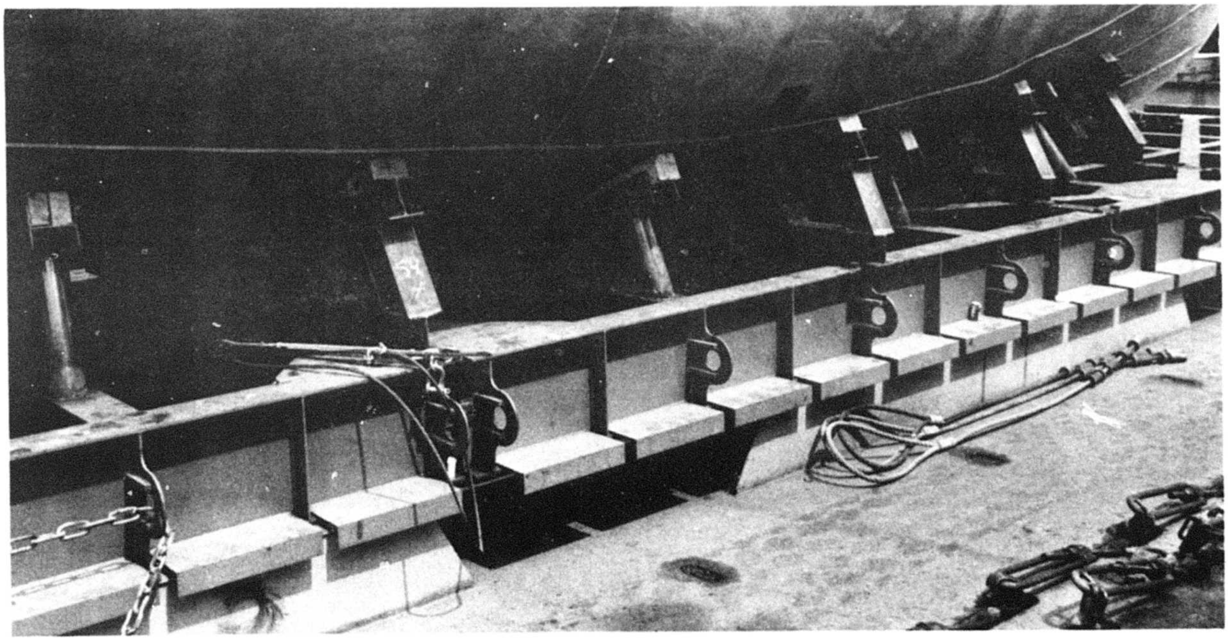
(a)



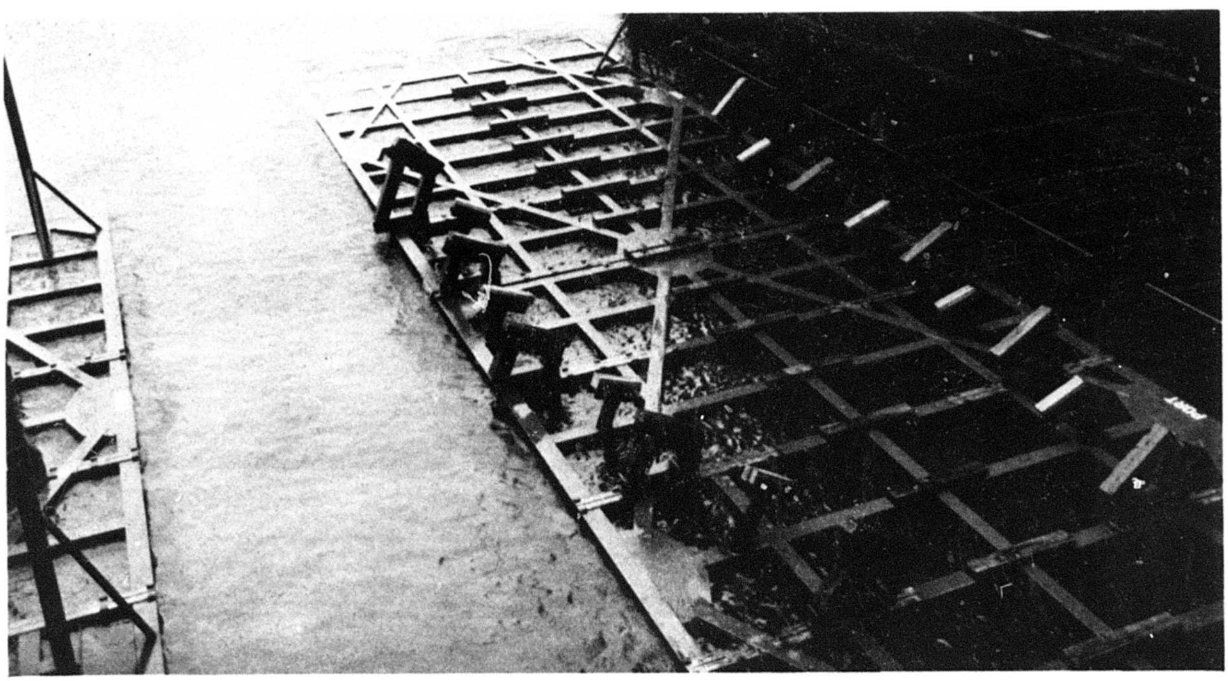
(b)

Figure 44 - I-Beam Chocks Supporting 100-Foot Tug
(Note distortion and twisting of sections
and failure of set screw fittings.)

The reinforcing of the chock system, shown in Figure 45, after liftout, was also inadequate. Figure 46 shows typical tack-weld of the original chock bases to the greased skid surfaces, a strict violation of any weld specification. Some welds did not even contact both surfaces.



(a)



(b)

Figure 45 - Reinforcing of Tug Skids (Added Chocks)

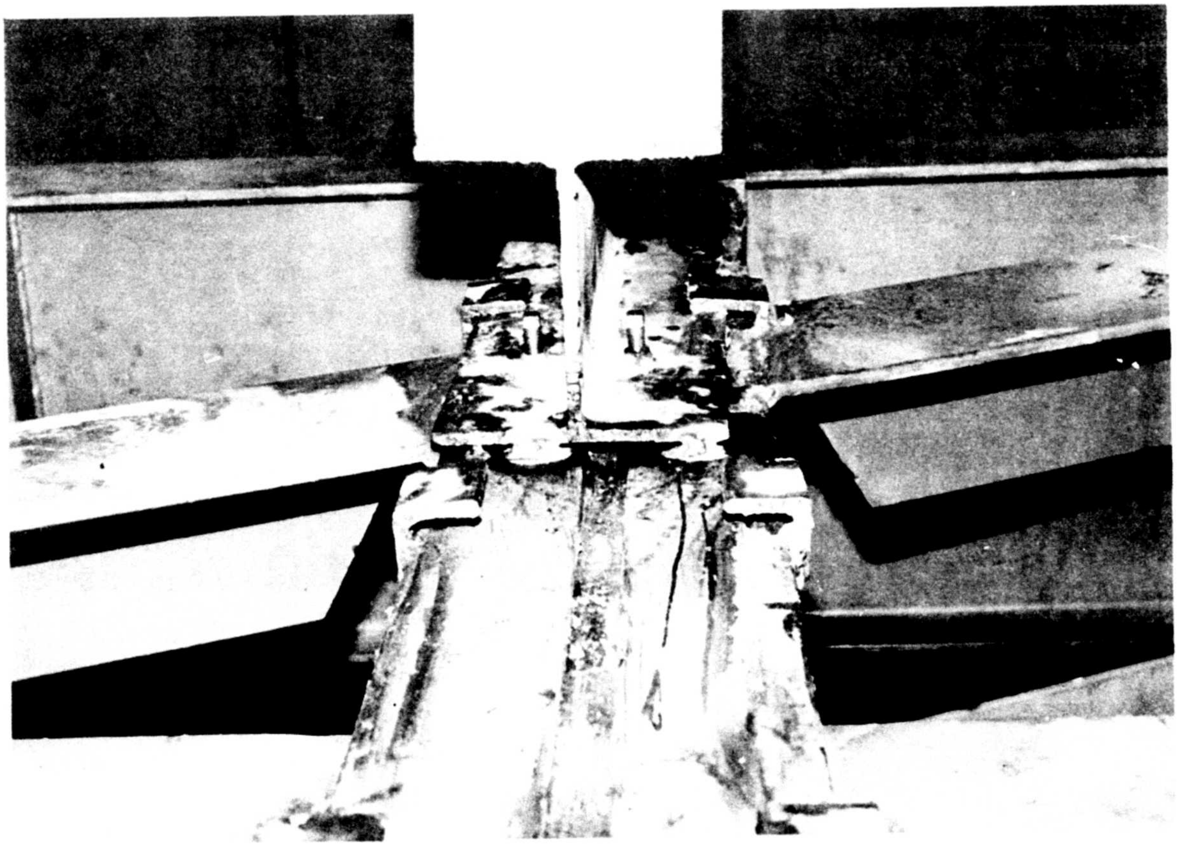


Figure 46 - Typical Tack Weld Repair to Original Chocks
(In many cases, weld did not penetrate greased skid beam)

These tugs have high Centers of Gravity (C.G.) and large moments of inertia and, consequently, can generate very high roll moments when resting on their keels and subjected to ship motions. Chocking and lashing of such inherently unstable loads should be professionally developed with final approval by qualified military and ship representatives. Skids should be wider to provide better angles for lashings and wider stance for supports.

The alignment posts on the skids, truncated to fit within the overhead of the main deck, became a hazard rather than an aid when submerged below the water surface. Figure 47 shows the 100-ft tug drifted into the submerged tops of the posts and Figure 44(b) shows resulting gouges in its hull.

The LCU CAF's were modified by welding short I-beam sections to their top surfaces as seen in Figure 48. This was considered unsatisfactory by the LCU commander because of the potential for damaging the hull plating with the sharp corners presented by the bare I-beams. Therefore, they were capped with

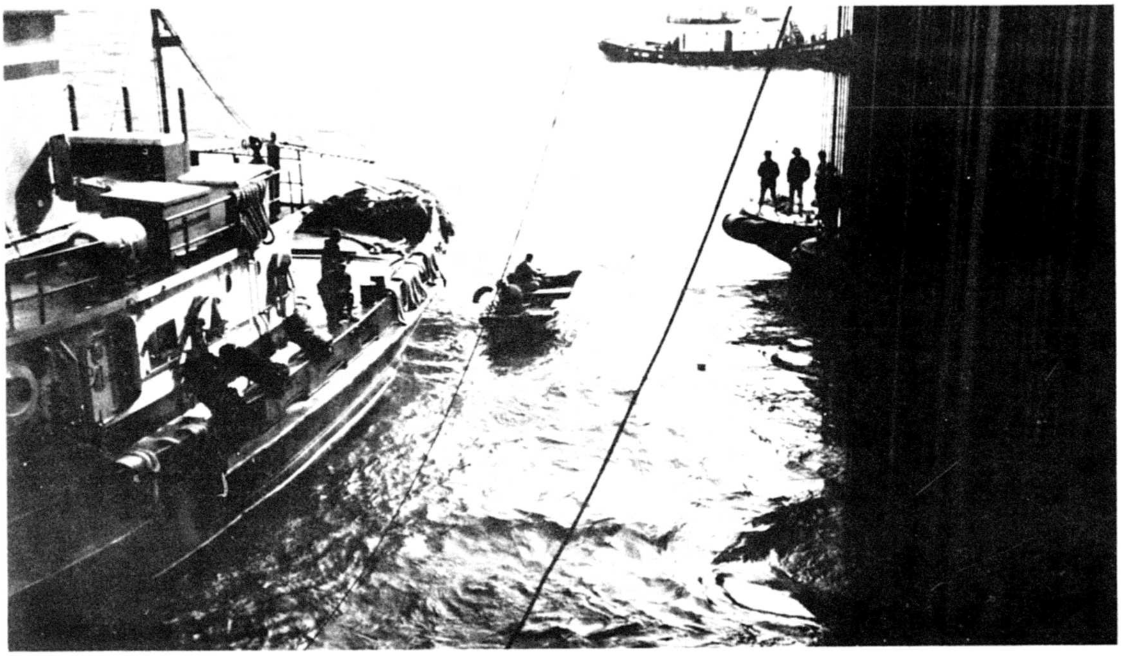


Figure 47 - 100-Foot Tug Drifted Down-Current into Tug Alignment Posts

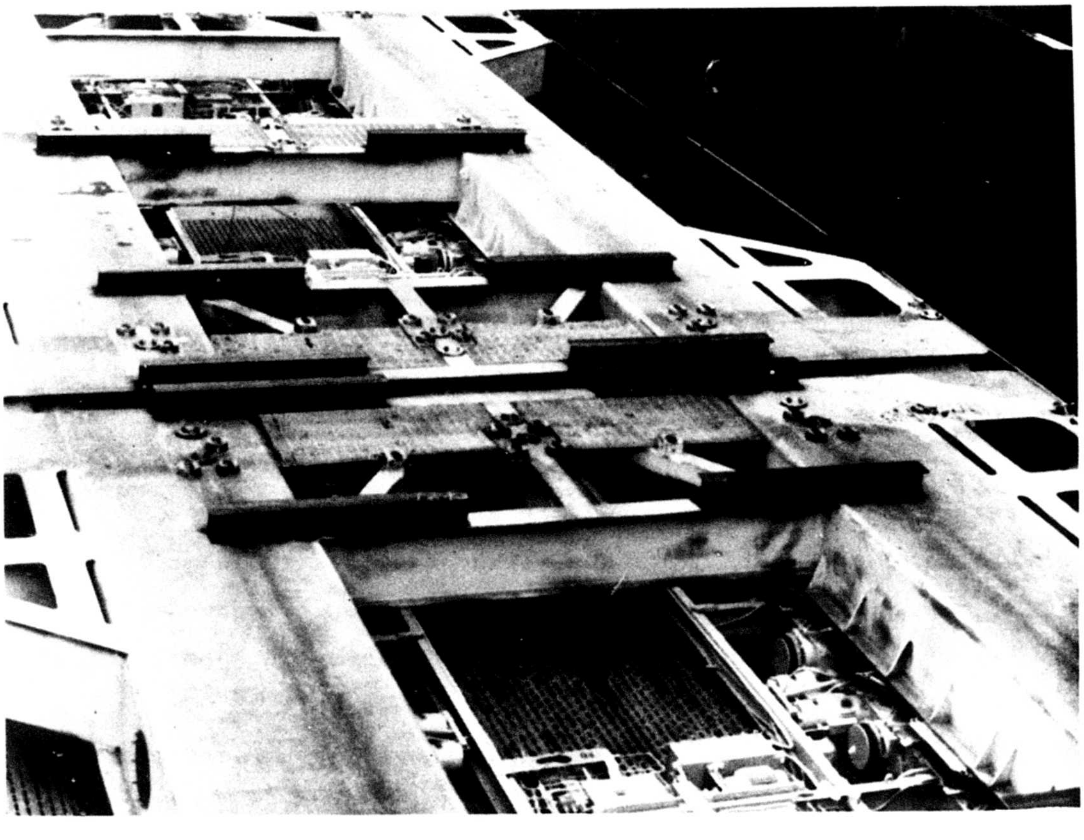


Figure 48 - LCU CAF's Showing Bare I-Beam Chocks

wood dunnage before proceeding with the loadout (shown in Figure 27, Section 2.3.2.2). This chock design was inadequate also because of the potential for bending the webs with surge and longitudinal forces which might result from transient contact between CAF and LCU during loading/offloading operations. Additionally, the limited bearing area presented by the beam surfaces is not adequate to support a craft loaded with cargo and subjected to a dynamic environment. "Oil Canning" of the hull bottoms was observed even in the mild environment of the test. A simpler, more supporting system can be made from broad wood beams spanning the width of the craft bottoms.

In preparing the LCU CAF, the chock pattern was installed backwards, i.e., for a bow-first vice a stern-first entry of the LCU's. As a result, the 1667 Class LCU Kort nozzle and skeg landed on chocks (see Figures 49 and 50) which should have been at the other end of the CAF (relative to the craft) to support the overhanging bows. Since there were no chocks under the loaded bows, wood dunnage was wedged underneath to relieve some of the stress on the craft structures. This is depicted in Figure 51. No damage was incurred by the craft.

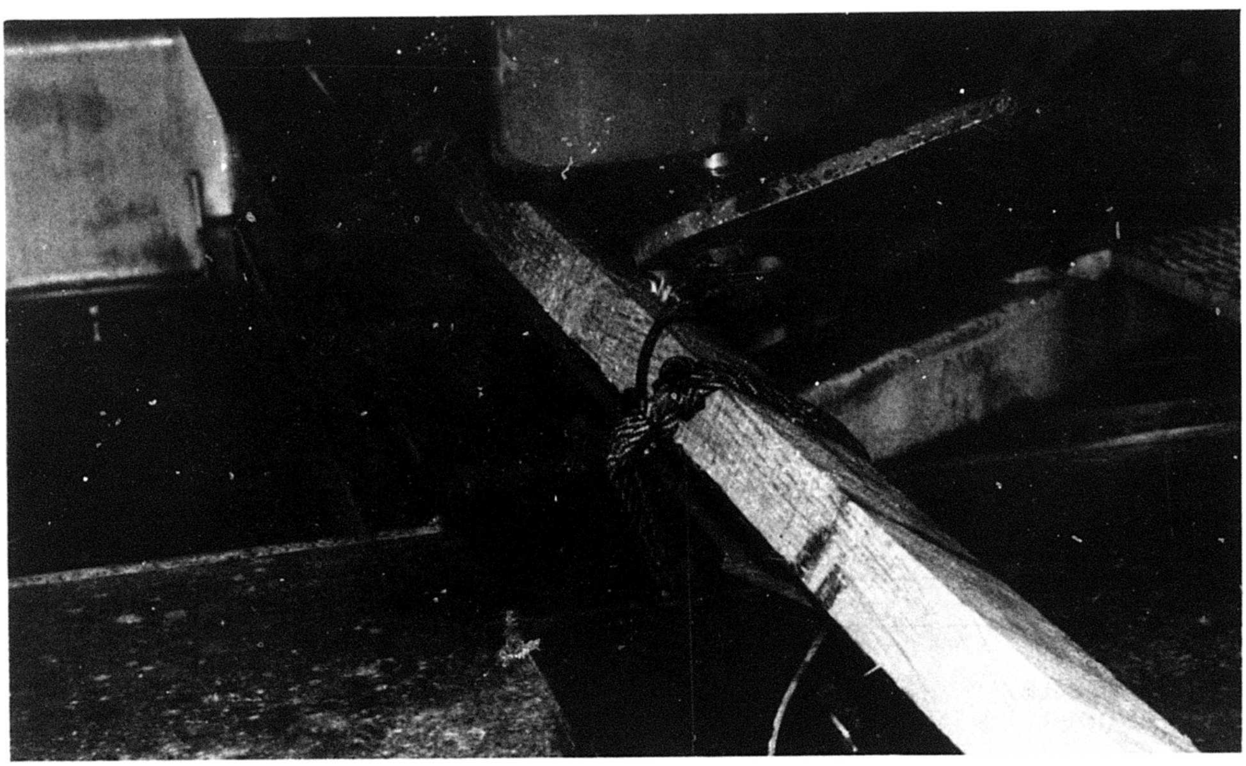


Figure 49 - Bent Over Chock Caused by Load of Kort Nozzle Rubber Post on LCU

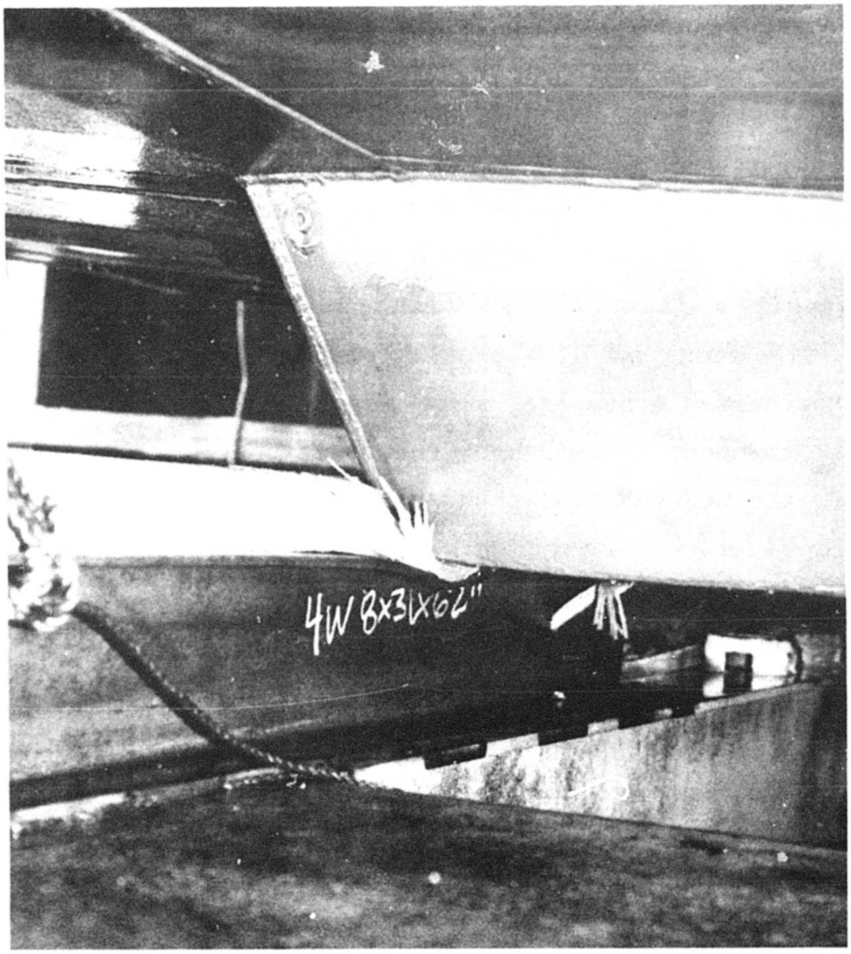


Figure 50 - LCU Skeg Overloading Beam-Chock

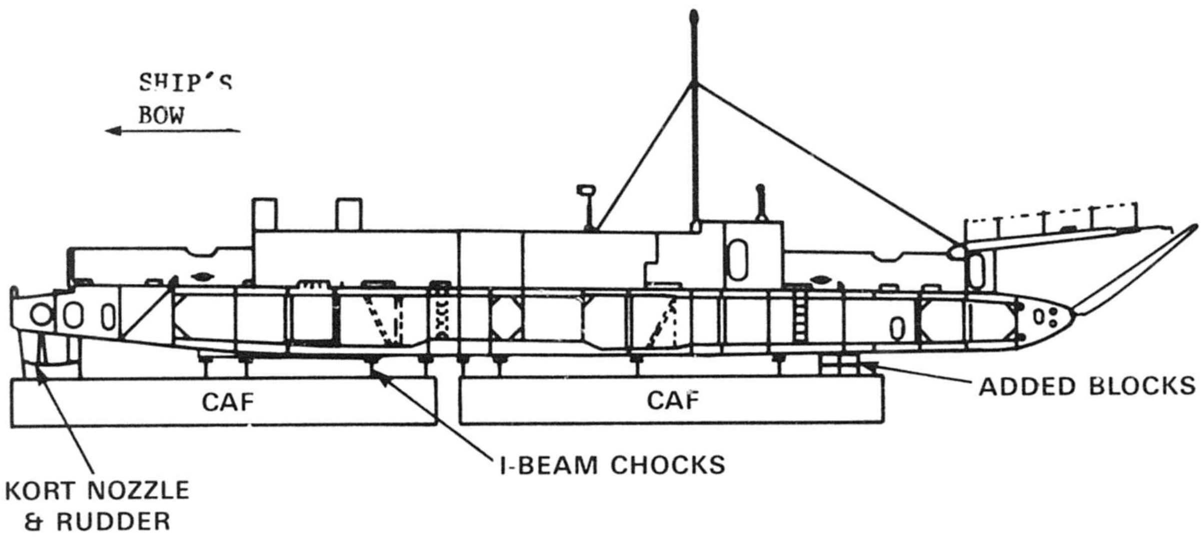


Figure 51 - LCU Reversed on CAF Chock Pattern
Overhanging Bow Required Additional Blocking

2.4.1.1.3 SHIP EQUIPMENT

The transporters worked well in both independent and synchronous modes. However, during the initial loadout of the TCDF the transporter jacks were unable to lift the barge (and its CAF's) totally free of the elevator pedestals. After reversing the barge and effecting a forward shift in the TCDF Center of Gravity, the barge was lifted free of the pedestals. This incident illustrated a limit of the transporter system which must be accounted for in future lifts.

The transit forward, in synchronous mode, to the stowage position was performed without incident. Prior to transferring the TCDF aft for boom assembly and launch, the synchronous system was down for about 20 min for a standard alignment check on the system. Presumably, this could have been done at another time to avoid the delay in offloading operations.

The ship's elevator system operated without failure during the test. However, in the interest of saving time, a more efficient tiedown system (e.g., Peck and Hale fittings) should be adopted to secure CAF's to the elevator pedestals.

The ship's positioning lines (with rings) were difficult to snag and haul aboard the craft entering the well. The problem could be eased by attaching a longer messenger terminating with a loop which could be easily snagged with boat hooks.

Before loading wheeled vehicles such as LARC-LX's which transit the deck on their wheels, deck clutter and obstacles should be removed as much as practicable to minimize damage and time delays. Figure 52 shows ship tie-down fittings, lying in the center isle of the upper deck, bent as a result of the LARC transits to their stow position. Figure 53 shows the guard rail around which the LARC's had to maneuver. The rail was removed for the LARC offload operation.

2.4.1.2 PROCEDURES

The procedures used to load the selected test cargo items were, on the whole, successful as was demonstrated by the fact that each cargo item was loaded aboard the ship and that no damage or injury was incurred.

General

During ship loading, the tidal current across the ship's stern was estimated as high as 1-1/2 knots. This made it difficult for the test cargo items to maneuver into the elevator well and moor, and resulted in several

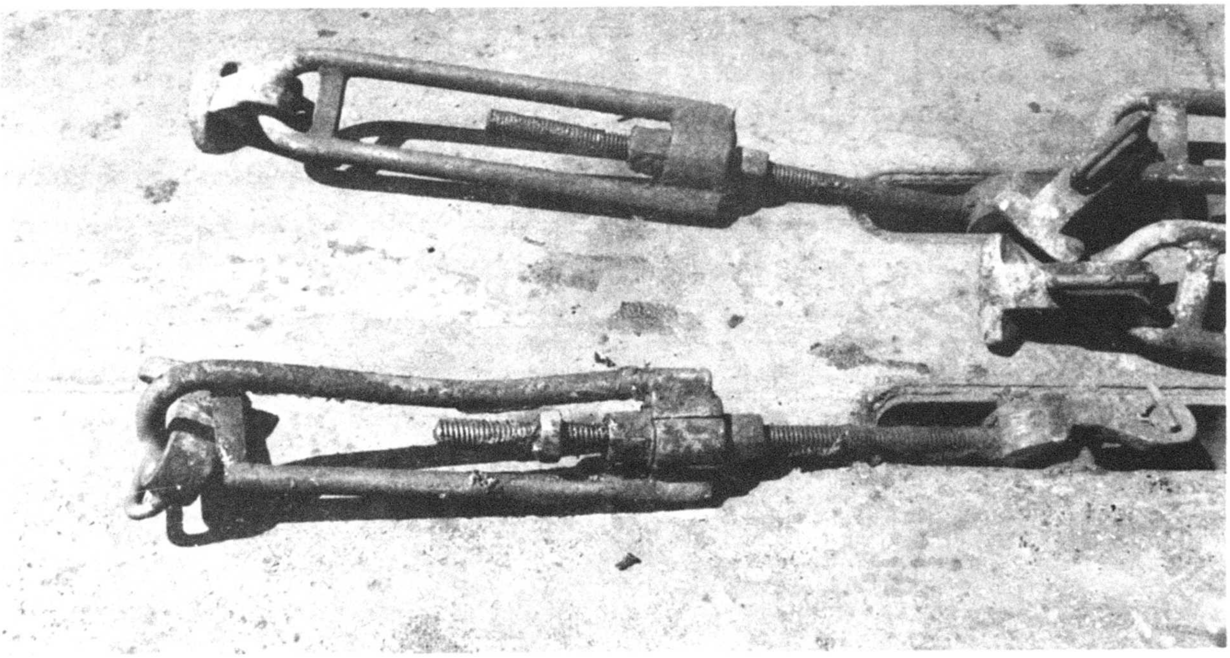


Figure 52 - Damage to Ship's Tiedown Fittings
Caused by LARC-LX Transit Up the Deck

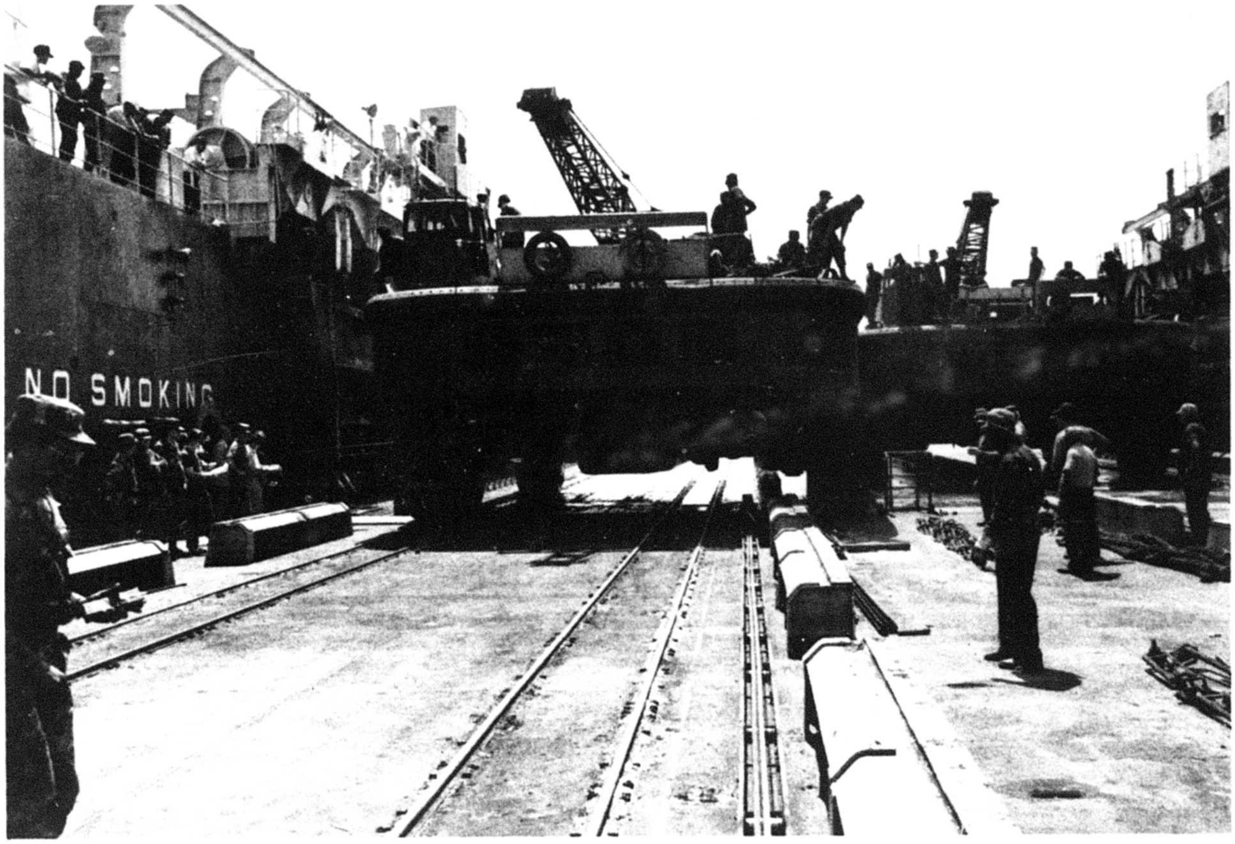


Figure 53 - LARC-LX Maneuvering between Pedestals
and Guard Rail Around Directors Platform

lengthy and, in the case of the 100-ft tug, dangerous loading procedures. In the future, the ship should moor in a position which minimizes the crosscurrent in the well. For example, it could moor stern first to reduce exposure to the main stream if the remaining pier area provided sufficient maneuvering room for the cargo items. Alternately, it could anchor in the stream.

If the crosscurrent cannot be avoided, then test results indicate that it is expedient to direct the "down-current" craft into the well first so it can drift into the ship's rub rail and receive lines. Then, the "up-current" craft can enter and drift into fenders on the first craft as depicted in Figure 54. Positioning and breast lines could then be rapidly rigged and the pair of craft aligned over their CAF's for liftout.

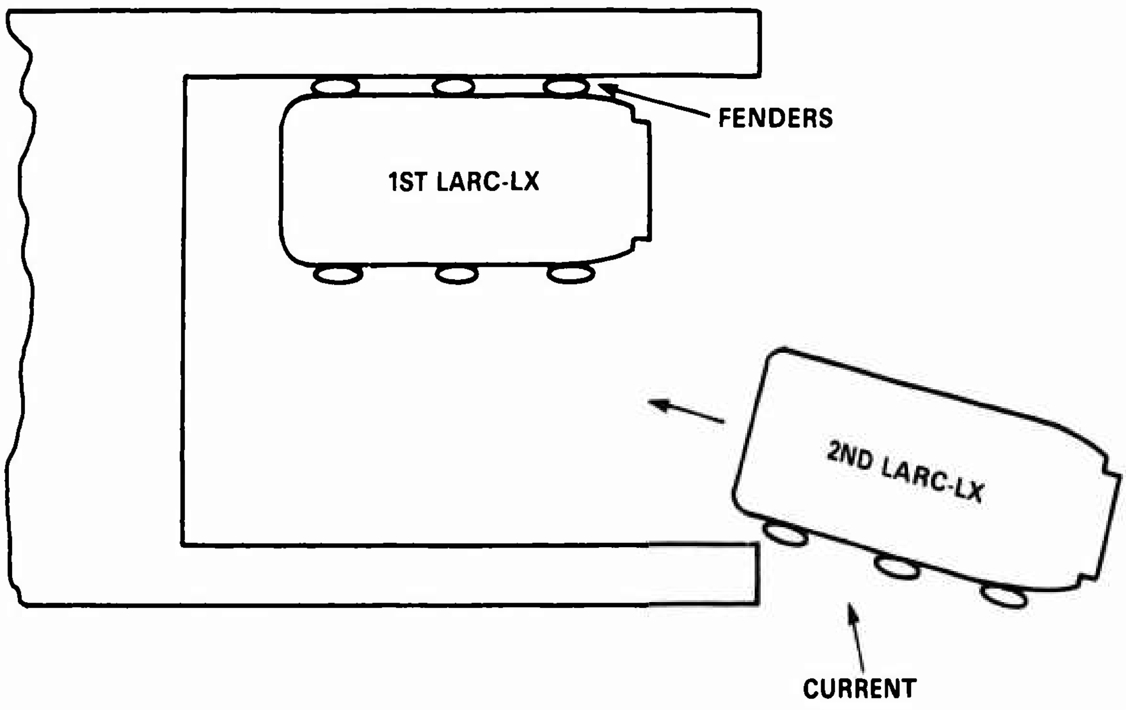


Figure 54 - Illustration of "Down-Current" Craft Entering Well First and Serving as a Guide during Entry of "Up-Current" Craft

For this procedure to be acceptable in the case of the tugs, the guide posts on the skids would have to be eliminated. Also, some consideration would have to be given to the structural capacity of the LACV-30 to absorb bumper loads in the event it were the down-current (first) craft. During offload, current and alignment were not problems since the aft streaming current at the anchorage assisted the craft to exit the well.

Direction for the entering and positioning of the craft was provided by the officer in charge of the unit being loaded who was positioned on the director's platform extending over the transom from the upper deck. He passed orders to the craft crews below and to the operators of the ship's positioning lines in the control stations atop the sidewalls. The first mate stood by for consultation and, on occasion, took control of the operation.

A more logical procedure would be for the first mate to act as dockmaster and direct all loading on his ship. The military officer-in-charge should direct all craft to the entrance of the elevator well. When the craft bow crosses the "sill" of the well, the first mate could assume direction of the craft for the remainder of the loading procedure. The military person would advise the mate on any peculiar handling requirements for the cargo items.

Docking procedures must be reviewed and rehearsed by all military crews participating in ship loadout.

Figure 55 is an illustration of a correct and incorrect hookup of the ship's positioning lines for alignment procedures. The initial hookup's, in almost every case, were similar to that depicted by the dashed lines. Lines so attached will pull the craft into the ship's transom. The solid lines represent a correct hookup configuration. These lines all produce opposing forces and can be used to position the craft over the CAF once it is in the elevator well. This applies to two craft lifts, also, as shown in Figure 39.

Under adverse sea or current conditions, the use of locally based commercial tugs, experienced in handling loaded SEABEE barges, could be a safer, faster, and perhaps less costly procedure in the long run.

The procedures for loading (and offloading) the tugboats in this test do not necessarily apply, following redesign of the material and arrangement of outfitting the skids for these units.

<u>TCDF Loading Procedures</u>

The only written procedure for loading, stowing, and offloading the test cargo items was for the TCDF. The original procedure specified that the TCDF

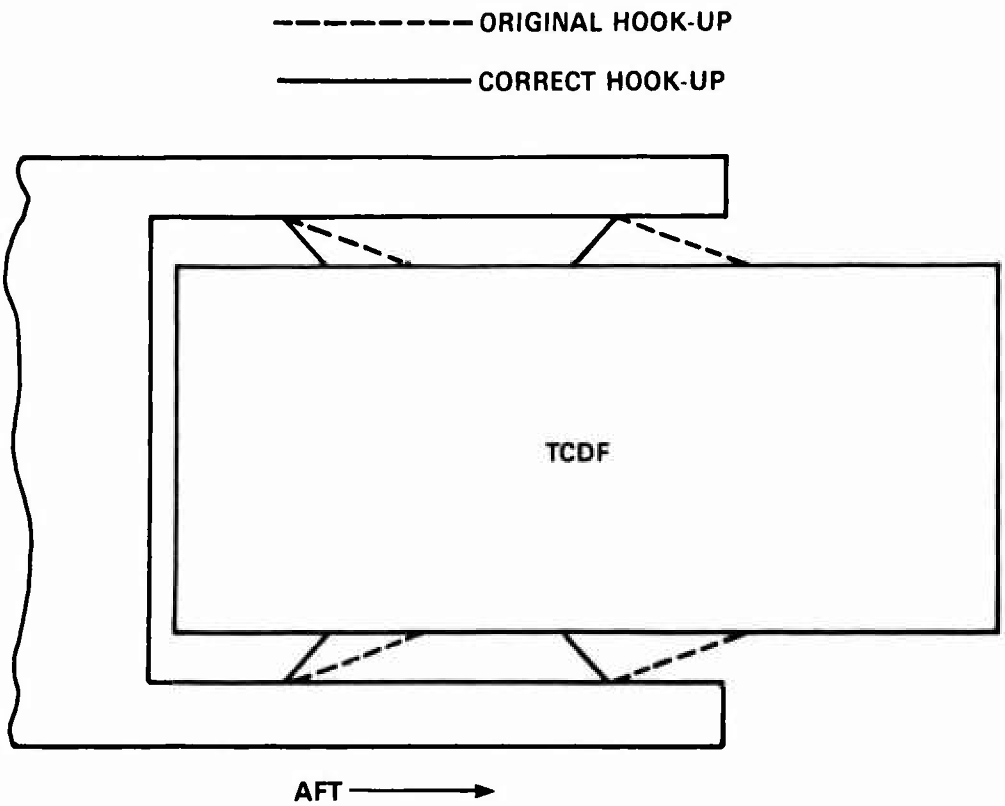


Figure 55 - Illustration of Correct Use of Ship's Positioning Lines
(Dashed lines show incorrect application)

was to be loaded stern-first. However, prior to the lift, the decision was made to load the TCDF bow first to accommodate reassembling the TCDF crane boom on the SEABEE deck without having to reverse the crane to do so. The following paragraphs discuss what happened and why the TCDF must be loaded stern-first.

Shiploading Arrangement. - The loading arrangement of the ship and of equipment aboard the TCDF is constrained by the following factors:

- The crane manufacturer requires the TCDF's long boom to be disassembled prior to loading aboard ship. The tip and an intermediate section of the boom were removed and stowed on the barge deck. The remaining length of the boom was within the bounds of the barge and was stowed on a framework mounted to its deck.
- The removed boom sections must be stowed on the TCDF deck in a location accessible to the mobile cranes.
- The TCDF must be preloaded so the barge floats with near zero trim to match that of the SEABEE elevator.

• For transit, the TCDF crane must be secured in position facing the bow of the barge (facing aft, shipwise). For assembly, the crane must be unlashed and rotated, facing forward, shipwise.

• The boom must be reassembled and the lift lines reeved on board ship prior to launching the TCDF. To do this, the TCDF must be lowered on the elevator to a level which allows the boom to rest horizontally on blocks on the upper deck as depicted in Figure 56.

• The mobile cranes used to assemble the boom must be forward (shipwise) of the TCDF. These were brought on board in the LARC-LX's.

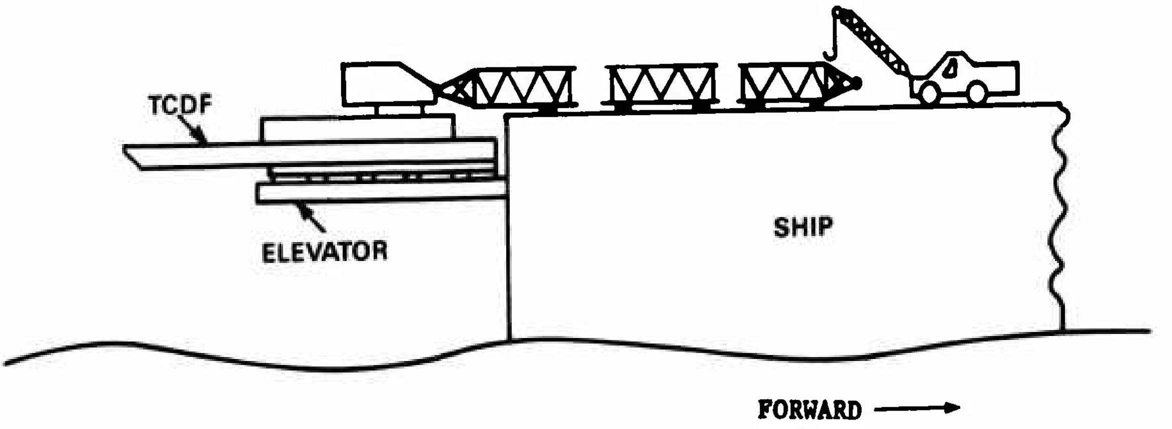


Figure 56 - Method Used to Assemble TCDF Boom

Center of Gravity. - A critical factor in the TCDF loadout is the location of its longitudinal C.G.. Factors controlling this location are:

• The location of equipment (weight distribution) on the TCDF barge and;

• The shape of the barge underbody (assuming the barge has a rectangular plan form and a flat deck).

Obviously, the first factor can be controlled, the second cannot (short of changing barges). With reference to Figure 57, the barge bottom is raked at the bow. The consequent loss of buoyancy (loss of displaced water volume) combined with the equipment location on the barge, results in a longitudinal C.G. about 4-ft aft of the barge center for the zero trim condition.

Factors which influence the preferred location of the TCDF C.G. for loading aboard a SEABEE ship are:

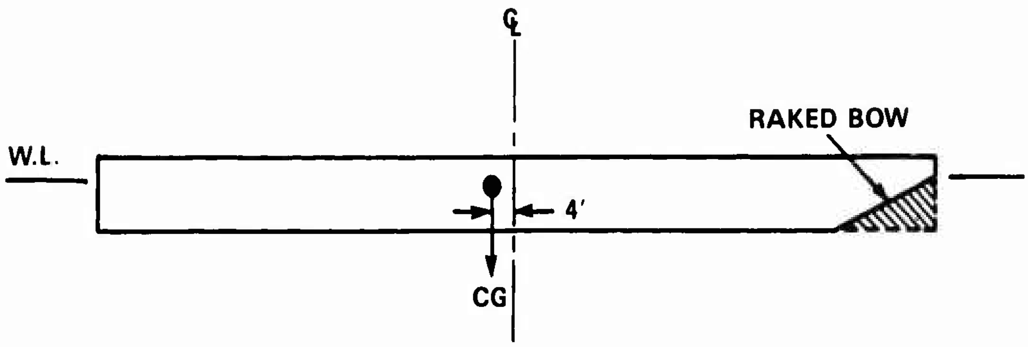


Figure 57 - Raked Bow Results in Lost Buoyancy Forward and a Center of Gravity Aft of Amidships

- The requirement for near zero trim so the barge settles onto its CAF uniformly along its length, i.e., the barge bottom should parallel the CAF dunnage and;
- The criticality of the TCDF C.G. position relative to the longitudinal center of the transporters when loaded onto the SEABEE elevator.

Only two pairs of CAF's can be positioned on the SEABEE elevator, spanning a length of about 100 ft. The TCDF barge is 150-ft long and, when one end is positioned coincident with the forward end of the CAF's on the elevator, the other end will cantilever about 50-ft aft of the CAF's. The result is a TCDF longitudinal C.G. location significantly aft of the center of the transporters, presenting an unsymmetrical load and pushing the limits of the transporter design envelope.

The criticality of the above factors was not fully realized during the planning for the TCDF onload and it was decided to load the barge bow-first for convenience since this would preclude the requirement to unlash the TCDF crane and rotate it 180 deg for the boom reassembly operation.

First Liftout - Bow-First. - Figure 58(a) shows that the after transporter jacks could not lift the CAF's free of the elevator pedestals forcing the bow of the TCDF to rotate up and off of the forward dunnage. In this configuration, the TCDF C.G. was about 29-ft aft of the longitudinal center of the transporters, creating a local overload on the stern jacks.

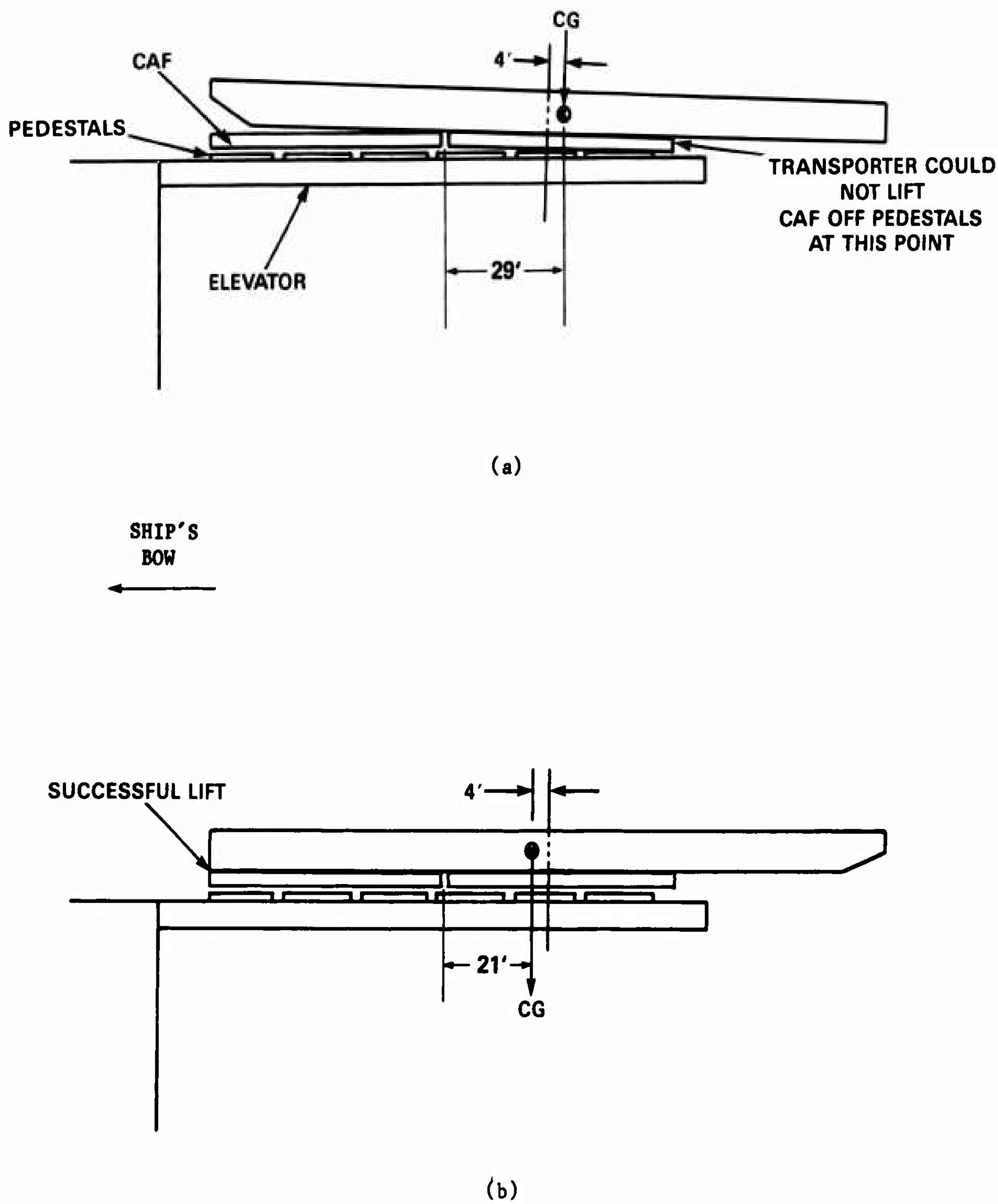


Figure 58 - Illustration of Marginal Capability of Transporter to Lift TCDF

Second Liftout - Stern-First. - The TCDF was refloated and loaded stern-first, effecting a forward shift in TCDF C.G. of about 8 ft, i.e., to a position 21-ft aft of the transporter center as depicted in Figure 58(b). In this configuration, the transporters were able to lift the TCDF CAF's free of the elevator pedestals and transit forward to the stowage area. However, the transporter lift was still not parallel to the pedestals indicating that the longitudinal asymmetry of the load was still bordering on the design limit of the transporter.

Stowing the TCDF. - The written procedure referred to above also defined a sequence in which the TCDF, supported on four CAF's, would be moved forward on the ship from the elevator to the upper deck stowage position, and then lowered onto shims 5-in. high, placed on top of the pedestals under the two pairs of CAF's. This would have provided sufficient clearance under the TCDF to permit moving two additional CAF's (a third pair) under the overhanging 50-ft of the TCDF. The shims would then have been removed and the TCDF set down on three pairs of CAF's to fully support its length. Instead, the third pair of CAF's was positioned (shipwise) aft of the TCDF, then the TCDF was lifted and moved aft over these two CAF's as depicted in Figure 59. The result was that the TCDF was supported on six CAF's, as intended, but the procedure sacrificed approximately 50-ft of upper deck space that subsequently could not be used for stowing cargo. The stowing procedure, along with the requirement for two LARC-LX's with cranes, resulted in the TCDF deployment requiring a length of 265-ft of upper deck space.

During the stowing operation, a clearance of only 1-1/2 in. was measured between the TCDF overhang and the third pair of CAF's. Possible causes of the small clearance were:

- The trim of the barge resulting from the slightly incomplete lift of the after jacks (1-1/4 in. differential from bow-to-stern of transporter).
- A sag in the barge structure because of the 50-ft of overhanging weight.
- The differences in height of dunnage caused by the crushing load on the forward CAF pairs relative to the unloaded dunnage on the after CAF pair.

The above discussion is intended to point out the marginal capability of this SEABEE ship to successfully lift and stow the TCDF as configured for this test. Other SEABEE ships may have less capacity for handling this asymmetrical

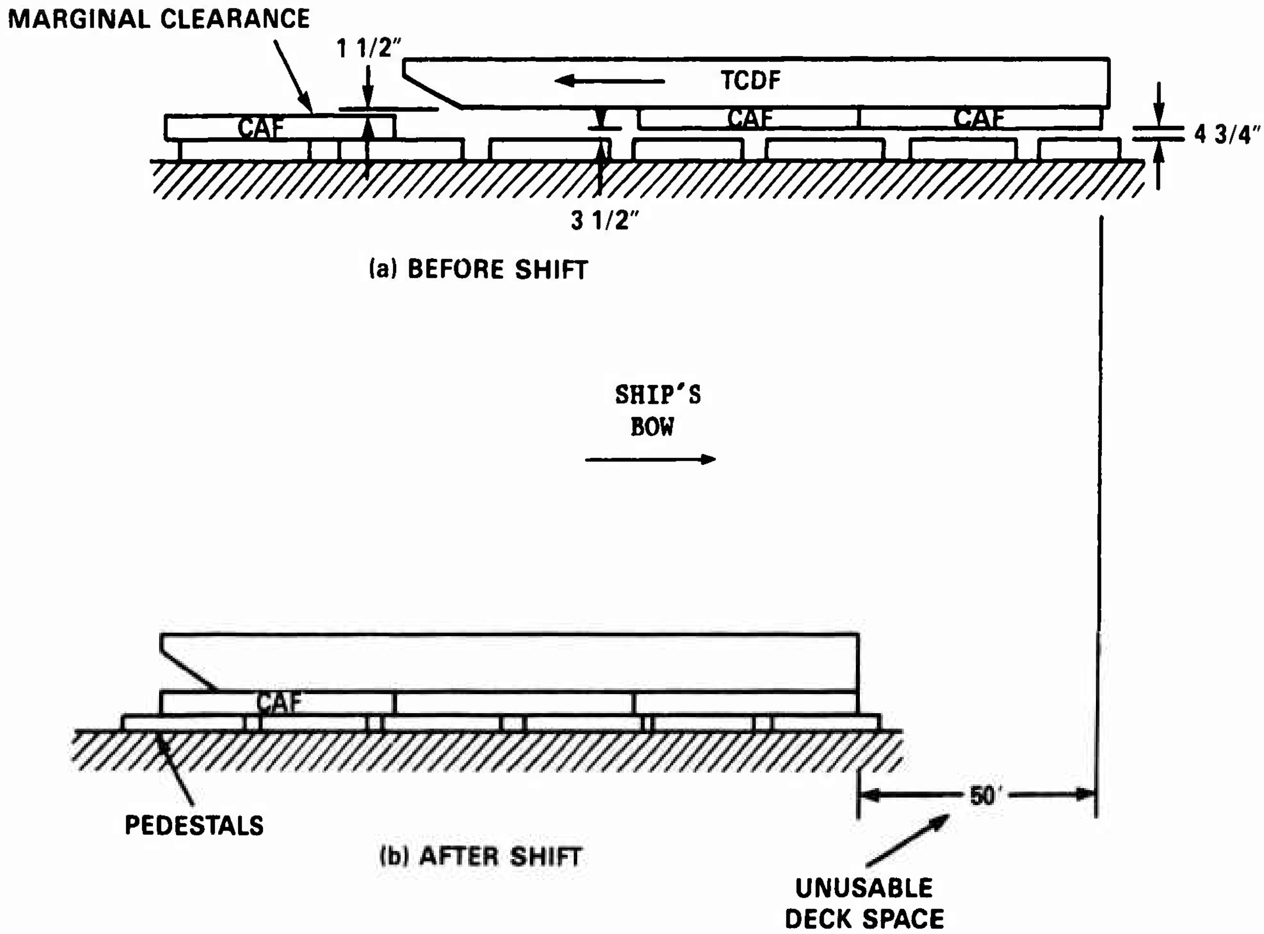


Figure 59 - Procedure Used to Install Third Pair of CAF's under TCDF

load, because of different equipment tolerances, wear, different manufacturer, etc. If the TCDF is to be in future LOTS inventories, the loadout operation should be reevaluated in light of the above experience.

2.4.1.3 PERSONNEL

Basically, ship operations were performed by ship's personnel and military crews operated military vehicles.

During ship loadout, special tasks such as chocking the tugboats required extra personnel (2 divers and 4 diver support personnel, and a dock master) and equipment (diver support boat). These personnel and equipment must be planned for on a case-by-case basis.

The task of loading and offloading barges is routine to the ship's personnel. They know their equipment and, within the bounds of the barge loading operation, they are "expert". The peculiarities presented by the various military configurations taken aboard presented them with unique situations. Because of their constant exercise in this environment, they were able to resolve, in coordination with military representatives, all of the problems which arose. However, some of their concepts, e.g., the tug and LCU chocks, were inadequate and demonstrate a limit to their capabilities. These areas need to be addressed by people with more appropriate qualifications.

The military crews of the individual craft performed the SEABEE loading mission for the first time. Maneuvering the craft into the confines of the elevator well required expertise in basic seamanship skills and the test results emphasized the need for extensive training in this area.

2.4.1.4 TIMES

Table 5 presents a breakdown of elapsed times for each of the loadout activities listed on the ordinate. The times in each vertical column are consecutive and the total time includes all delays which occurred during a particular lift, e.g., stopping for inspection, adding chocks, making decisions on unexpected problems, etc. Footnotes are added for clarification.

These times are of "one-time" events. They reflect the learning and experimentation which might be expected of crews in a first-time experience on an unfamiliar operation.

Time in the loadout operation may not be a critical factor since this is not a repetitive operation. On the other hand, the operation should reflect an attempt to expedite, while not infringing on safety, since the LOTS cargo handling operations cannot begin until LOTS equipment is deployed.

2.4.1.5 ENVIRONMENTAL IMPACTS

The only environmental factor which affected the loading operations was the tidal current (varied from 0 to about 1-1/2 knots). This crosscurrent, which ran abeam of the moored ship, made the craft entry into the elevator well and positioning over the CAF difficult tasks.

TABLE 5 - SEABEE LOADOUT TIMES
(Hours and Minutes)

Lift / Event	Lift 1	Lift 2	Lift 3	Lift 4	Lift 5
	Cube Barge LCAV-30	LARC's (2)	TCDF*	Tugs (2)**	LCU's
Secure CAF to Elevator	1:16	N/A	0:36	0:55	1:46***
Elevator Submerged (Includes flooding)	0:18	0:09	0:17	3:01	0:14
Craft Approach Elevator and Position Over CAF	0:23	0:30	0:41	5:32	1:11
Lift Elevator	0:27	0:18	0:27	9:43	0:46
Position Transporter, Lift Load, and Transit Onto Stowage Deck	0:13	0:35	0:09	0:41	0:14
Transit and Set Load Onto Pedestal	0:45	0:07	2:18	0:07	0:05
Transporter Position CAF's on Elevator for Next Lift	0:24	0:24	1:01	1:15	N/A
TOTAL	3:46	2:03	5:29	21:14	4:16

*These times are for the second TCDF lift only.

**The lengthy times logged for the tugboat onload result from the following delays:.

- Elevator submerged - 3:01 - Includes time to ballast ship down to approximate the trim of tug keels.
- Approach and position on elevator - 5:32 - Includes time for divers to position and recheck sliding chocks.
- Lift - 9:43 - Includes times to install additional chocks to supplement the damaged sliding chocks, and add chain tiedowns.

***The 1:46 includes time to cap the I-beam chocks on the LCU CAF with wood dunnage.

2.4.2 SHIP OFFLOAD

With few exceptions, the offload of the test cargo items proceeded smoothly and without incident. Although, the launching of the various craft was simpler than the loadout operation, it was obvious that both military and ship crews had gained experience during the loadout which enhanced their performance during offload. The difficulty of entering and aligning the craft in the elevator well in a crosscurrent at a pier was replaced by the simpler task of releasing the craft in a streaming current at an anchorage. However, safety, timing, and coordination are as important in the offload as they are during onload because of the dynamics associated with operations in a relatively unprotected environment, i.e., at anchor in the stream.

2.4.2.1 EQUIPMENT

The performance of LOTS equipment items or test cargo, support equipment, and ship's equipment are discussed for ship offloading operations.

2.4.2.1.1 TEST CARGO

The cargo items were offloaded in the reverse order from onload. The difficulties which they presented when hauled out of the water had already been resolved and did not effect the offload operations.

2.4.2.1.2 SUPPORT EQUIPMENT

As in the loadout, the CAF's were flooded as they were submerged. When they were brought up and stowed on the main deck to clear the elevator for the next launch, they would not completely drain because of the location of the access ports. It can be assumed that corrosion will occur within their box beam structures, especially at the welds. Future use of these CAF's for military operations should be preceded by a structural inspection.

The other major support equipment used in the offload were the two mobile cranes brought aboard in the LARC-LX's and used in the reassembly of the TCDF boom. These items performed the task with no difficulty.

2.4.2.1.3 SHIP'S CARGO HANDLING EQUIPMENT

During the offload of the TCDF, the transporters were inoperative for approximately half an hour while the synchronization system was realigned. This was a tuning operation not a failure repair. There were no delays resulting from failed ship's equipment. The ship proved to be a very stable platform and the elevator well sheltered the launching craft from the wind and waves.

2.4.2.2 PROCEDURES

The procedures for launching the test cargo were essentially the reverse of the shiploading procedures. However, launching operations were much smoother because of experience acquired by crews during loading and because launching involved the release of lines rather than the more difficult task of aligning the craft and rigging the mooring lines.

2.4.2.3 PERSONNEL

Although, the offload operation was not as skill demanding as onload (except for the TCDF boom assembly and the launch of the LACV-30 in heavy weather), the relative smoothness of the crew performance demonstrated some learning curve effect, i.e., some of the onload experience was useful during offload operations.

2.4.2.4 TIMES

Table 6 presents a breakdown of elapsed times for each of the offload operations. The unique event during offload was the TCDF boom assembly. All other events were similar to the onload, except reversed.

2.4.2.5 ENVIRONMENTAL IMPACTS (SEABEE OFFLOADING)

For the most part, the environmental conditions during offload operations were ideal. There were no significant crosscurrents during offload since the ship was at anchor and streaming with the prevailing current. The only significant weather related problem was a short test delay of less than an hour when a severe squall passed through the area. Wind velocities up to 65 knots were recorded on the bridge. When this occurred the LACV-30 was still in its stowage position with all of the craft's stowage tie-down lashings previously removed. The strong winds had no adverse effect on the LACV-30 and once the winds calmed, the test continued.

TABLE 6 - SEABEE OFFLOAD TIMES
(Hours and Minutes)

Event / Lift	Lift 1	Lift 2	Lift 3	Lift 4	Lift 5
	LCU's	Tugs	TCDF	LARC's	LACV-30*
Movement of Load from Stow Onto Elevator	0:13	0:39	2:23**	0:14	0:35
Securing Adapter Frames/Skids to the Elevator	0:21	0:38	0:15	N/A	0:05
Start Down and Depart Ship	0:13	0:26	4:47***	0:16	0:16
Raise Elevator and Reposition for Next Lift	0:14	2:13	0:35	0:23	0:56
TOTAL	1:01	3:56	8:00	0:53	1:52

*Cube Barge not offloaded.

**Includes times to stow 3rd pair of CAF's and to realign transporter synchronization.

***Crane assembly required 4 hr-24 min

2.5 CONCLUSIONS AND RECOMMENDATIONS - SEABEE TEST

2.5.1 DEPLOYMENT OF LOTS EQUIPMENT ON SEABEE SHIPS

The overall mission of the test was to load the selected test cargo items aboard a SEABEE ship at a pier utilizing the ship's loading equipment, stow them on deck, and offload them at an anchorage. The mission was carried out with the teamwork of the military and shipboard personnel, and without injury to personnel or damage to equipment other than some bent tiedown fixtures. The ship's equipment was shown capable of handling the outsized loads, and the ship's crew was knowledgeable and cooperative. The only marginal capability was in the loading of the TCDF. The sensitivity of the transporter lift capacity to the aft position of the TCDF C.G., when loaded on the ship's elevator, points out the need for a reevaluation of the loadout configuration of the TCDF. The total operation was conducted in moderate weather disturbed only by crosscurrents in the well during ship loadout at the pier and by an afternoon squall during offload of the LACV-30, the last item launched. The offload of equipment appeared to be a simpler operation and was accomplished without incident.

Some of the mistakes and misjudgements which occurred point out the need for closer pre-operations planning between ship's company, military representatives, and technical advisors to ensure that items such as chock designs, adaptor frame modifications, loading procedures, command and control, ballasting requirements, dimensional interferences, tiedown configurations, etc., are all properly considered and agreed upon.

It was obvious that a docking plan was not available during onloading operations. In addition, the crews lacked proficiency in basic seamanship skills (boat handling, line handling). Training and prebriefing are a necessity if such specialized operations are to be accomplished safely and efficiently.

The CAF and the newly designed SEABEE skids were both acceptable base structures. However, the skids should be made wider (same as CAF) to provide a wider stance for chock supports and a better angle for lashings. The surface arrangement of the skid provides a uniform rectangular grid on which can be mounted dunnage, bracing, and chocks tailored to support each of the cargo items tested. The "hour glass" plan form of the CAF's is not suitable for supporting tug boats, for example, because of the lack of a uniform width for mounting chocks and insufficient centerline surface for uniform support of the keel. Extensive structural additions would be required to make the CAF suitable for supporting the tugs.

2.5.2 PLANNING FACTORS

Planning factors for the deployment of Army LOTS equipment on SEABEE ships are developed for ship loading and discharge TIMES, MANPOWER requirements, and SUPPORT EQUIPMENT required. Since ship loading and discharge operations are not expected to be repetitive events, time planning factors were not developed to great detail. Support equipment planning factors are developed for deployment of the equipment selected for the JLOTS II test. Time and support planning factors for other unique deployed equipment must be estimated.

2.5.2.1 TIME

The time to load and offload LOTS equipment on a SEABEE ship can be broken down into time to accomplish an elevator lift when the elevator is carrying equipment with similar handling characteristics and support requirements. Table 7 gives general time planning factors for loading JLOTS II test cargo on the SEABEE ship.

TABLE 7 - PLANNING FACTOR TIMES FOR SEABEE SHIP LOADING

Equipment Type	LCU's LACV-30 Cube Barge	LARC-LX	TCDF	Tugs
Loading Time (per elevator lift)	4 hr	2 hr	5-1/2 hr	12 hr

Similarly, the time planning factors for offloading these are given in Table 8.

TABLE 8 - PLANNING FACTOR TIMES FOR SEABEE SHIP OFFLOADING

Equipment Type	LCU's LARC-LX LACV-30 Cube Barge	Tugs	TCDF
Offloading Time (per elevator lift)	1 hr	4 hr	8 hr (4-hr mil boom assy)

2.5.2.2 MANPOWER

The manpower required for deploying Army LOTS equipment on SEABEE ships consists of both ship's crew and military crews of cargo items.

2.5.2.3 SUPPORT EQUIPMENT

Support equipment for deployment of major LOTS items falls into two categories. The first is the equipment or material needed to interface the cargo items to the ship's handling gear and stowage facilities. The second is the equipment needed to bring the cargo items to the ship during onload and retrieve them from the ship during offload.

The principal interface equipments are the CAF's and the SEABEE skids, each with a unique chocking system to accommodate specific cargo items. The quantities needed to load cargo items similar to those tested are listed in Table 9.

All self-propelled items can enter and exit the elevator well under their own power. The TCDF required two tugs for assistance.

2.5.3 EQUIPMENT

Recommendations pertaining to equipment for deployment of selected LOTS items aboard a SEABEE ship are given in the following sections.

TABLE 9 - SEABEE SHIP INTERFACE PLANNING FACTORS

Cargo Item	TCDF	LCU Cube Barge BC Barge**	LACV-30 LCM-8**	100-Ft Tug	65-Ft Tug	LARC-LX
No. of* CAF's/ Skids Needed	6	2	1	2 (skid)	1 (skid)	0

*Where not specified, either CAF's or skids will apply. Tug boats require the more uniform support surface of the skid structure. In all cases, the surface of the CAF/skid must be prepared with support material required by the cargo item to be loaded.

**Loaded in JLOTS I - Sep 1977

2.5.3.1 MILITARY EQUIPMENT

Four recommendations regarding the military equipment tested are as follows:

- In order to improve efficiency of the alignment of military cargo during loadout of the SEABEE ship, chocks or fairleads should be installed on the item in locations for appropriate orientation of the ship's positioning lines, as illustrated in Figure 60. If factors such as craft size, existing current, and wind, etc., make it difficult to hold craft in position during the alignment procedure, further constraint can be achieved by adding spring lines (shown dotted in the figure). Temporary/portable fair leads would be acceptable.
- Reevaluate the TCDF loading configuration with regard to C.G. location, trim, requirements for onboard boom assembly, etc., to ensure compatibility with the SEABEE loading equipment.
- Develop adequate LACV-30 and tugboat tie-down configurations for storm sea conditions.
- Require all cargo items (water craft, etc.) to carry boat hooks.

2.5.3.2 SHIP'S EQUIPMENT

Four recommendations concerning ships equipment are listed below:

- Clear decks of clutter and obstacles.
- Attach longer messengers with looped ends to ship's positioning line rings for easier access by boat hook.
- Install bull horn in elevator well area for communicating with military crews.
- Use "quick" lashings, such as Peck and Hale, for securing CAF's to elevator pedestals.

2.5.3.3 SUPPORT EQUIPMENT

The following are two recommendations concerning cargo-ship interface platforms.

- Because of the relatively fragile load-bearing surfaces of most water craft when stowed out of the water, modifications or surface preparation (dunnage, bracing, chocks, D-rings, etc.) of the CAF's/skids should be specified by a certified Naval Architect (if not already approved and documented) for each military cargo item to be loaded aboard ship in order to ensure its adequate

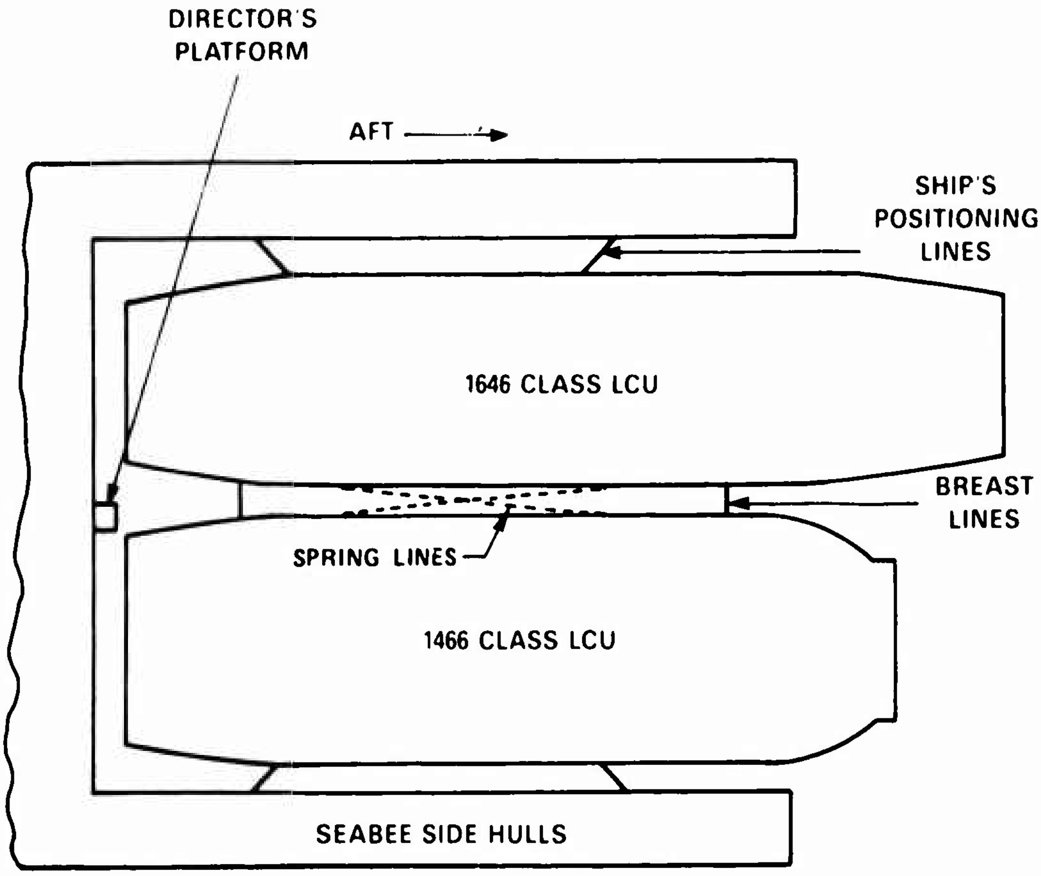


Figure 60 - Proper Hook-Up of Breast and Spring Lines and Positioning Lines

support and safety. This applies especially to lifting and securing large, unstable cargo items such as tug boats.

- The SEABEE skids should be redesigned to be as wide as the CAF's to provide a wider platform for chocks and other supporting structure and to provide a wider angle for lashings from the cargo item to the skid D-rings.

2.5.4 PROCEDURES

Following are recommendations concerning procedures for deployment of LOTS equipment aboard SEABEE ships.

- Use of commercial tugs with experienced operators to assist the TCDF into the elevator well would be more expedient and less hazardous than use of military tugs with operators inexperienced in SEABEE ship operations.

- Develop a docking plan with the assistance of ship operators which identifies: entry and alignment procedures, chock locations for hookup, command and communications procedures, etc.

• Maintain continuous training of military crews in basic seamanship and conduct pre-operation briefings and training in preparation for special operations such as loading on/offloading from a SEABEE ship.

• Pre-operation planning should include identification of critical dimensions of the cargo-ship interface, hard points, stow requirements, chock locations, ballast requirements, and other features of both the ship and military cargo which are relevant to this type of operation.

• When loading craft over-the-stern with a crosscurrent running, it is simpler to have the "down-current" craft enter the elevator well first. This craft then provides a fendered side to guide the "up-current" craft into its slot. An alternate would be to load the ship at anchor in the stream to minimize crosscurrent problems.

2.5.5 MANAGEMENT AND CONTROL

Ship's crew are "experts" at loading barges onto their ship. This experience is directly related to the loadout of military cargo. Therefore, once the cargo item is delivered to the ship's boundary (the entrance to the elevator well or alongside) the ship's crew should assume control of the loading/offloading operations. A military authority should advise on special considerations regarding handling and arrangement of the military equipment.

3.0 LASH TEST

The following sections provide a description of the test components and pretest preparations, a summary of the test events, a discussion and analysis of the test, and conclusions and recommendations.

3.1 TEST COMPONENTS

The ship, interface hardware, test cargo, support equipment, operating units, and the test area are described in the following paragraphs.

3.1.1 LASH SHIP

The LASH ship that participated in the test was the SS LASH PACIFICO chartered by the Military Sealift Command (MSC) from Prudential Lines. The ship is one of 18 LASH ships in the U.S. Flag merchant fleet and is a single deck vessel designed to carry cargo barges in barge cells and on the main deck. There are two classes of LASH ships, the C8 and C9, as shown in Figures 61 and 62. Table 10 provides a comparison between the two classes. The C8 Class SS LASH PACIFICO, as well as several others, is configured to carry a partial load of containers on deck and in cells and to carry liquid bulk cargo in wing tanks. The barges are lifted and placed on the ship by a gantry crane which travels forward and aft on rails on the main deck.

The holds of the LASH ship are essentially open spaces with heavy vertical guides at the hatch corners. The guides vertically align the barges and prevent shifting during severe ship motion in heavy weather. Each cargo hold has several levels of walkways (gratings) clear of the barge stowage area. These walkways enable the ship's crew to connect and disconnect cargo ventilation and dehumidification lines to the barges. LASH ships have their barge (and container) cells oriented so that the long axis of the barge (or container) runs athwart ship. The barges are stacked vertically in their cells up to the weather deck. After the hatch covers are installed, barges may be stacked two-high on the weather deck. Barges are nominally 61-ft long x 31-ft wide x 11-ft high. The lift height of the gantry crane is designed to allow a hatch cover to be moved over two barges stacked above deck.

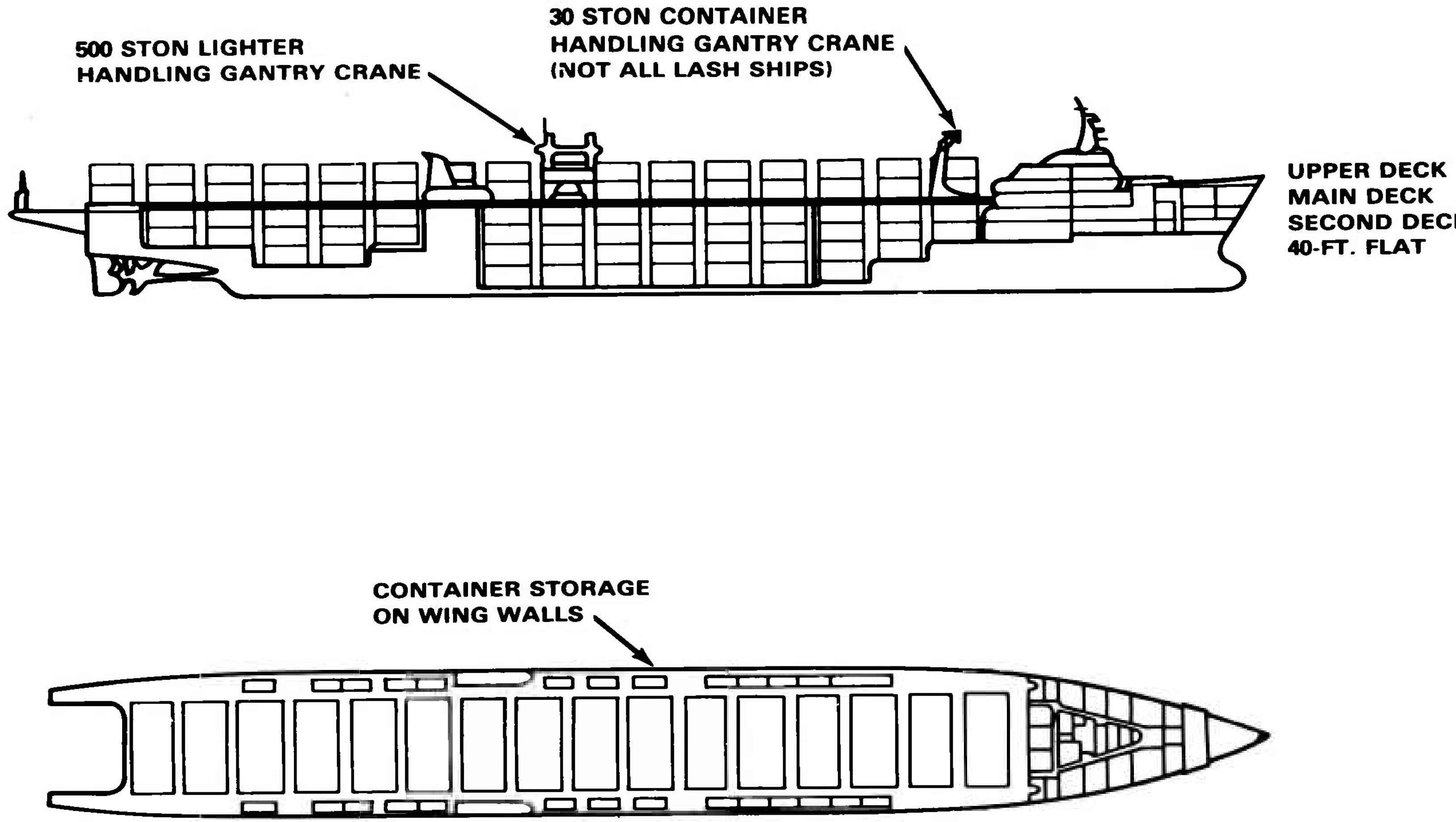


Figure 61 - C8 LASH Vessel

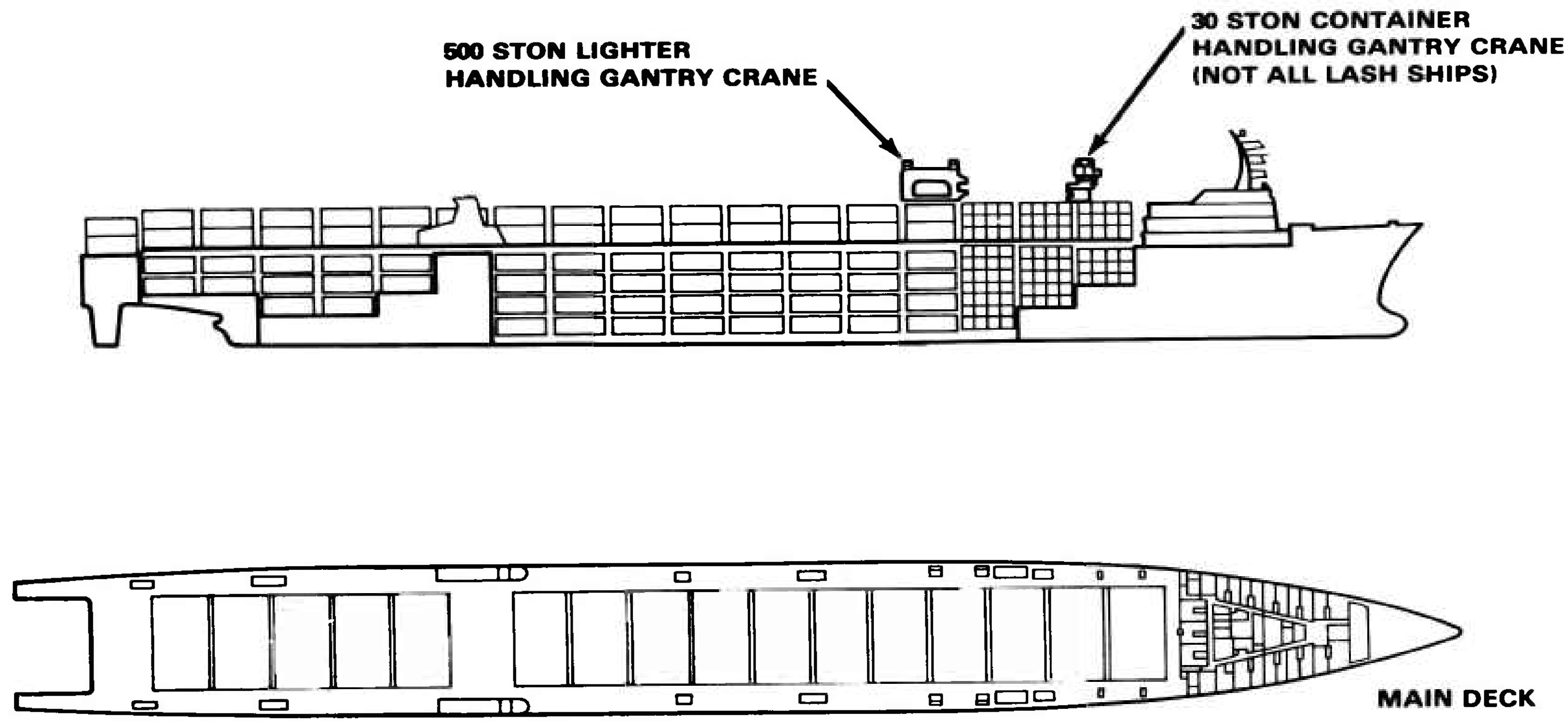


Figure 62 - C9 LASH Vessel

TABLE 10 - CHARACTERISTICS OF U.S. FLAG SHIPS

	C8-S-81b	C9-S-81d
LENGTH (OVERALL)	820ft.	893ft. 4in.
LENGTH (BETWEEN PERPENDICULARS)	724ft.	797ft. 4in.
BEAM (MOLDED)	100ft.	100ft. 0in.
DRAFT (DESIGN)	28ft.	28ft. 0in.
DRAFT (MAXIMUM)	35ft.	38ft. 0in.
DEPTH (MOLDED)	60ft.	60ft. 0in.
CARGO DEADWEIGHT*		
DESIGN, TONS	7,436	7,929
MAXIMUM, TONS	19,036	24,854
CARGO VOLUME (cubic feet),		
BALE CUBE IN LIGHTERS	1,215,200	1,744,400
LIGHTSHIP	14,230†	16,020†
DISPLACEMENT, TONS		
AT 28ft.	32,650	38,075
AT 35ft.	44,250	NA
AT 38ft.	NA	57,082
LIGHTERS	49-73‡	74-89‡
SHAFT HORSEPOWER	32,000	32,000
SPEED (AT 28ft.)	22.5kn	22.0kn

* ALL WEIGHTS ARE IN LONG TONS.

† APPROXIMATE FIGURES.

‡ LARGER NUMBER IS MAXIMUM CAPACITY OF LIGHTERS FOR EACH HULL TYPE; LESSER NUMBER REFLECTS REDUCED LIGHTERAGE CAPACITY TO ALLOW FOR CONTAINER STOWAGE IN HOLDS

3.1.2 LASH INTERFACE HARDWARE

Since normal cargo operations aboard a LASH ship involves the gantry crane, it is necessary to devise ways to handle military cargo using this system. The gantry cranes are designed specifically to lift and carry the LASH barges. The barges are oriented with their long axis athwartships when the gantry crane attaches to them. Attachment points are located at each corner of the barge and, correspondingly, at each corner of the crane's Barge Lifting Frame (BLF). Earlier programs developed a Landing Craft, Mechanized (LCM)-8 Lift Beam and a Cantilevered Lift Frame (CLF) to interface between the Barge Lifting Frame and LCM-8's and pontoon causeway sections. The LCM-8 Lift Beam has been evaluated in prior testing, so it was not included in the JLOTS II test. The CLF developed and fabricated earlier was involved in only very limited testing. During early planning of the JLOTS II Deployment Test, Navy planning of LASH ship utilization for deploying Amphibious Logistic System (ALS) equipment revealed that the current CLF design was unable to lift many of the desired loads. The Navy then initiated design and fabrication of a modified CLF that would have the needed lift capability. The modified CLF, (Figure 63), was evaluated in JLOTS II. Its basic requirement is to adapt the ship's Barge Lifting Frame to lift Navy pontoon causeway sections having equipment prestowed on their decks. Causeway sections are nominally 92-ft long x 21-ft wide x 5-ft high which is too long to be lifted athwart ships like the LASH barges. They, therefore, have to be lifted with the stern end cantilevered out beyond the end of the LASH gantry crane. The CLF compensates for this with a counterweight which is attached to its forward end. The center of gravity (C.G.) of the combined CLF and causeway section being lifted is not centered under the gantry and, therefore, places a greater load in the stern connection pins between the Barge Lifting Frame and the CLF. As the weight of the causeway section and its cargo approaches the maximum of 300,000 lb, the C.G. must be moved forward to prevent overloading those connection pins. This complex relationship between the size, weight, and location of the cargo on the causeway and the required location of the C.G. of the total lift is solved using a computer program and the loading procedure discussed in Section 3.4.1.2. The CLF is outfitted with padeyes so that causeway sections can be lifted on the ship's centerline, either port or starboard sides (Figure 64), or side-by-side in a dual lift (Figure 63).

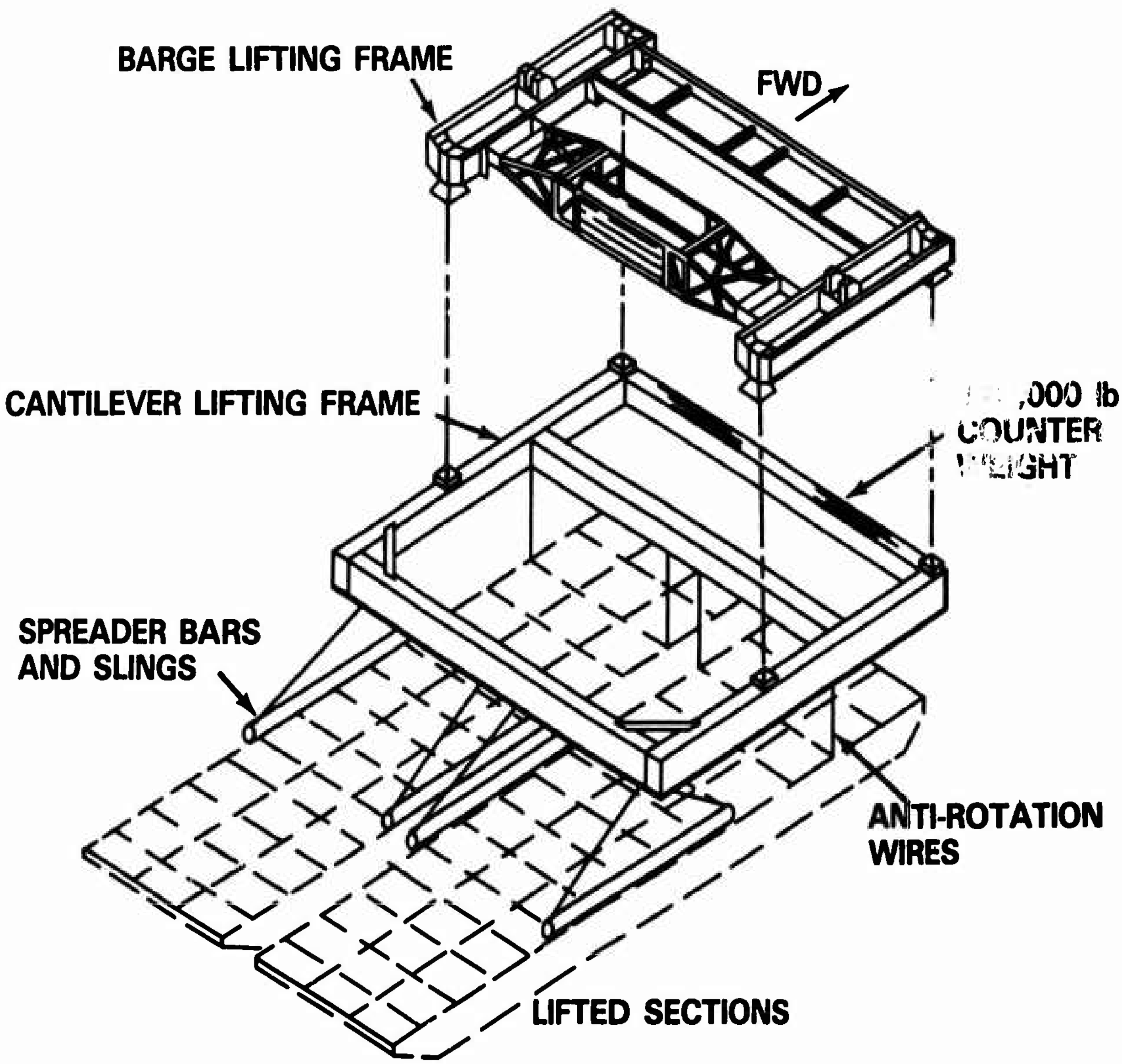


Figure 63 - Modified Cantilever Lift Frame (CLF)

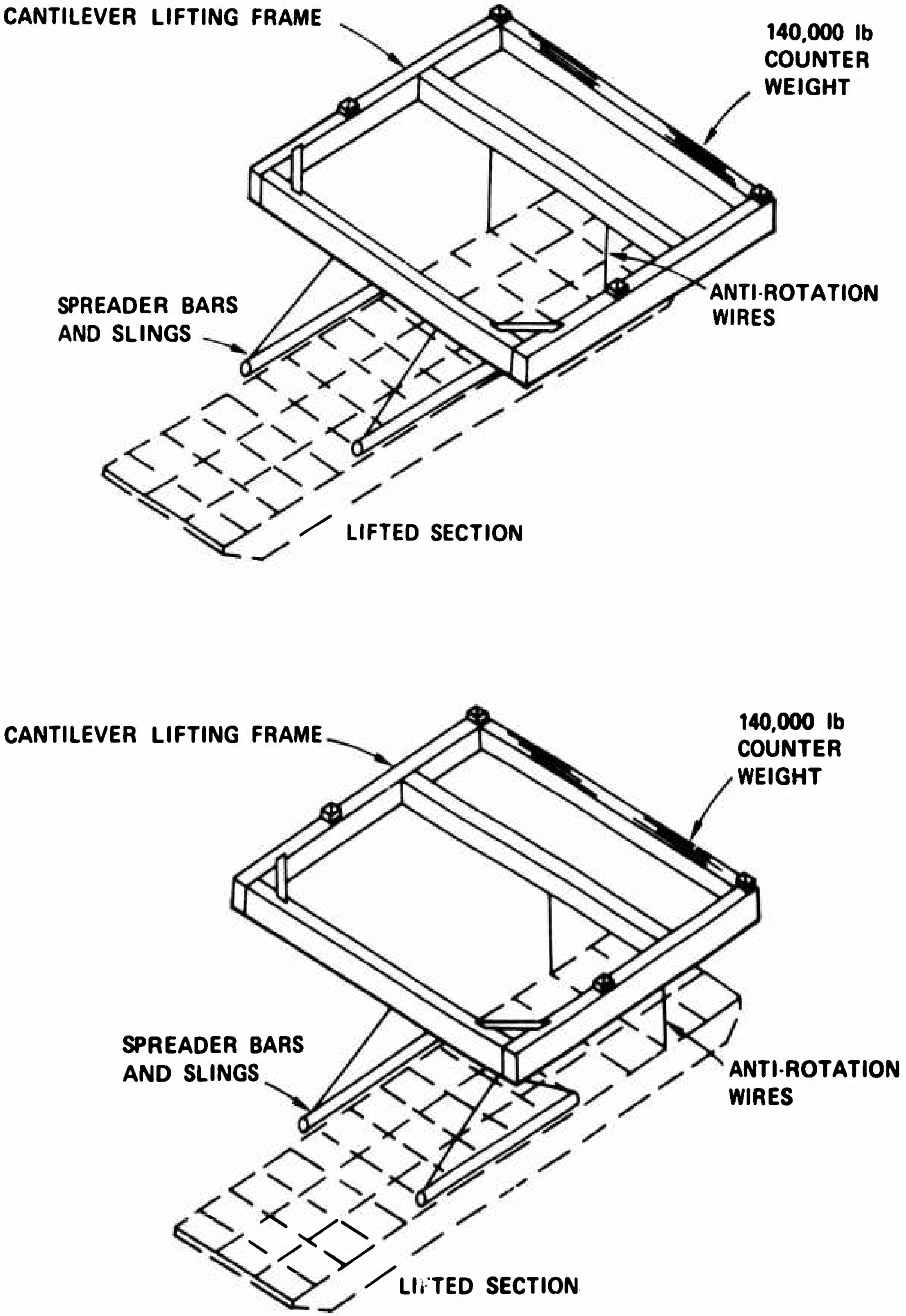


Figure 64 - CLF Center and Side Lifts

The total weight of the causeway sections(s) and their cargo cannot exceed the CLF design limit of 300,000 lb. There are two types of gantry cranes on U.S. Flag LASH ships, Morgan and Alliance. At present, the Morgan gantry crane has a limit on off-center loads of 240,000 lb. A design is being provided under a Navy contract which will permit modification of a Morgan crane to allow the full 300,000 lb off-center lift. The CLF sling configurations are depicted in Figures 65 and 66. The long slings are used to lift the section from the water and place it in its storage location. If it has to be lifted above the limits of the long slings in order to be stacked, then the section is set on the ship's deck and the short slings are substituted for the long slings and anti-rotation wires.

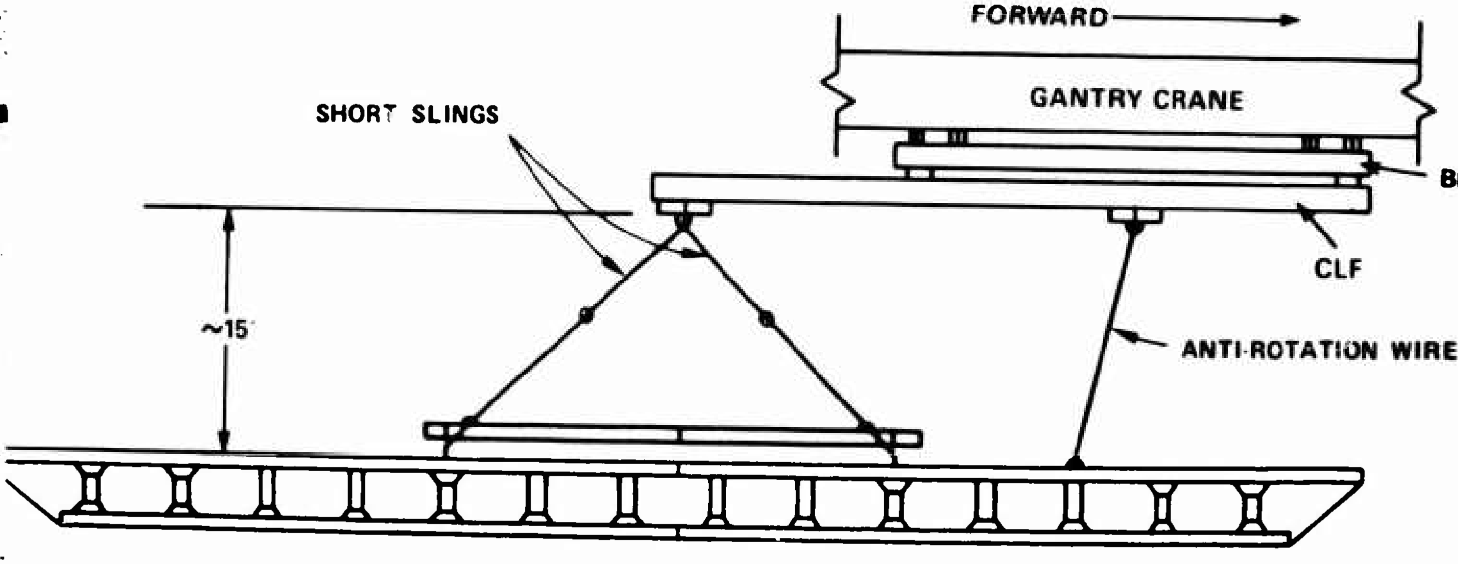


Figure 65 - CLF Long Sling Configuration

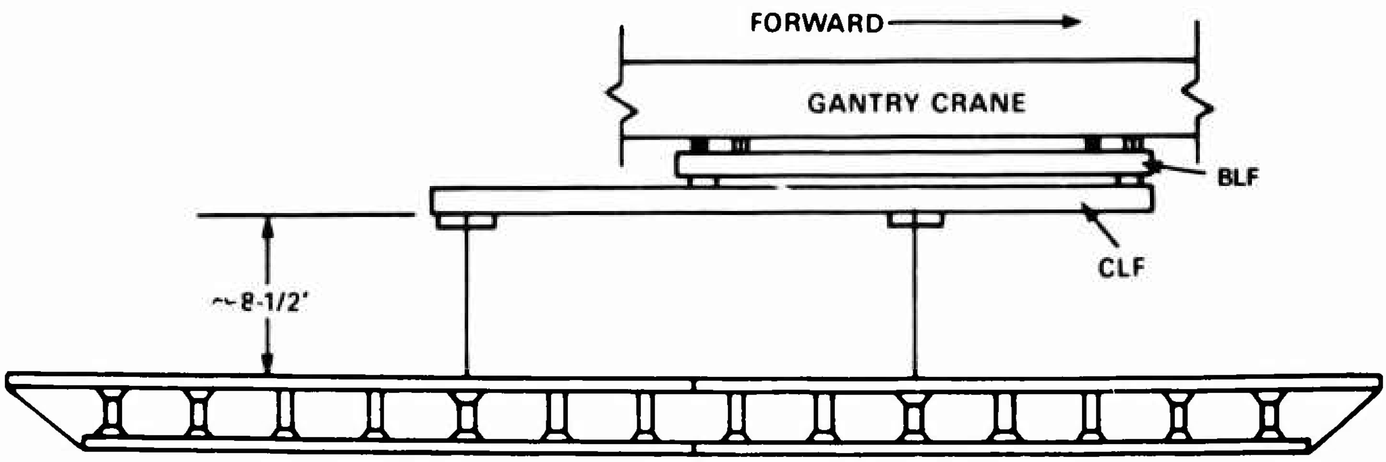


Figure 66 - CLF Short Sling Configuration

3.1.3 MILITARY TEST CARGO

Table 11 lists the military equipment deployed on the LASH ship. All of the equipment except the LACV-30 was provided by Amphibious Construction Battalion Two (PHIBCB TWO), Naval Amphibious Base, Little Creek, Norfolk, Virginia. The majority of the equipment is from the Elevated Causeway (ELCAS) system. The pierhead and roadway causeway sections were loaded with the largest and heaviest items used in construction of the ELCAS. The pierhead section weight varies depending on the number of internal spudwells (ISW) it has.

TABLE 11 - MILITARY EQUIPMENT SELECTED FOR DEPLOYMENT TESTING ON LASH SHIP

LIFT NO.	DESCRIPTION	LIFT WEIGHT (APPROX) W/LASHINGS	OVERALL LENGTH (FEET, APPROXIMATE)	WIDTH	HEIGHT*
1	2 Pierhead Sections (4ISW/6ISW) Side-by-Side Lifted Simultaneously (Width 21+21+6=48)	330,000 lb (ABS Test)***	92	48	5, 6.5**
2	Approx. 1140-ft of 20-in. OD Steel Pipe Piling on One ELCAS Roadway Section	330,000 lb (ABS Test)***	92	21	10
3	One TD-25 Bulldozer and One Super-20 Forklift on One Pierhead (4ISW) Section	270,000 lb	92	21	16.1
4	140T ELCAS Crane w/o Boom or Counterweights on One Roadway Section	256,000 lb	92	21	18
5	Two ELCAS Fender Strings on One ELCAS Roadway Section	225,700 lb	92	21	16
6	One 30T Hydraulic Crane on One ELCAS Roadway Section	215,900 lb	92	21	17.75
7	One ELCAS Turntable on One Pierhead (4ISW) Section	181,000 lb	92	21	8
8	60T Hydraulic Crane on One ELCAS Roadway Section	238,500 lb	92	21	17.3
9	Tactical Causeway Section	138,000 lb	92	21	5
10	Tactical Causeway Section	138,000 lb	92	21	5
11	Side-Loadable Warping Tug	208,000 lb	87	21	12
12	LACV-30****	56,300 lb	76.5	36.8	21.5

*Includes causeway section of 5-ft height

**Starboard section included 1.5-ft bitts. Dunnage was stacked 2-ft high so next section would clear the bitts.

***American Bureau of Shipping (ABS) Test. Refer to Section 3.3.2.3.

****From U.S. Army TM55-1930-218-14, Technical Manual, Transportability Guidance, LACV-30.

3.1.4 SUPPORT EQUIPMENT

During all phases of the LASH ship test (loadout, offloading, and backloading) the support equipment consisted of Navy warping tugs and LCM-6 causeway tender boats. Prior to ship arrival the CLF was assembled on a barge with the aid of a pier gantry crane and a floating crane.

3.1.5 OPERATING UNITS

The operating units participating in the LASH test were primarily Navy, with Army participation by the Seventh Transportation Group, the command having control of the LACV-30. Stevedoring services were provided in port by the Naval Supply Center, Norfolk, and in the discharge area by the Army Seventh Transportation Group. All other operating and support organizations were elements of Naval Beach Group Two, principally Amphibious Construction Battalion Two who provided all the test equipment other than the LACV-30.

3.1.6 TEST AREA

The LASH loadout took place at Pier 4, Naval Supply Center, Norfolk, Virginia. The offload and backload were conducted at an anchorage approximately one mile off Fort Story, Virginia. The test ended with the test items afloat in the test area.

3.2 PRETEST PREPARATION

Prior to initiation of detailed planning for the deployment test, the Navy contracted with a marine engineering and consulting firm to develop a manual[4] for loadout of LASH ships to deploy various items of the ALS including the Elevated Causeway (ELCAS), Offshore Bulk Fuel System, Powered Causeway, and RO/RO Discharge Facility. During review of a draft of this manual, it was found that some of the ship load units could not be lifted by the current design CLF. The Navy subsequently prepared a modified design CLF for the required capacity and acquired a prototype with the necessary slings and spreaders for the test.

The LASH loading manual, specified the calculations for loading and lashing the miscellaneous equipment on the causeway sections and recommended a lashing arrangement to secure the loads to the ship for storm seas.

American Bureau of Shipping (ABS) certification was required of the CLF contractor as part of the Navy acceptance test for the article. The length of the LASH ship charter was extended to accommodate ABS certification testing prior to the deployment test. The CLF received its certification in a one day test on 18 July 1984. The proof test lifts were made up of causeway sections required for the deployment test and extra weight to achieve a 10% overload, as required by ABS. The ABS proof test lifts were left on board the LASH ship and counted as JLOTS II deployment test lifts. The extra weights were removed by the ship's container gantry crane. The test then moved immediately into the remainder of the JLOTS II deployment lifts.

The selected ELCAS and tactical causeway sections were prepared by Amphibious Construction Battalion Two. The preparations consisted of installing the D-rings which were used to connect the anti-rotation wires to the causeway sections and placing and securing the various materials and equipment on the sections (Table 11).

Extra padeyes were installed on the ship's hatch covers in position 4S (Figure 67) for a sample attachment of the lashings for storm-sea conditions. Wooden dunnage was also provided to distribute the loads on the hatch covers and to prevent the causeway sections from damaging the hatch covers.

3.3 SUMMARY OF LASH TEST EVENTS

The LASH ship, LASH PACIFICO, was onloaded with selected military test equipment while moored to Pier 4 at the Naval Base, Norfolk, Virginia and the equipment was offloaded from the ship at an anchorage off Fort Story, Virginia. The actual test events are listed below.

3.3.1 LASH TEST SCHEDULE (Refer to the test article descriptions in Section 3.1.3)

18 July - Ship arrival at pier side, Naval Supply Center, NSC, Norfolk.

Attach the CLF to ships gantry crane.

Load two empty causeway sections and section with piling (with additional weights for ABS Certification Test).

Load causeway sections carrying bulldozer plus forklift and 140-ton crane.

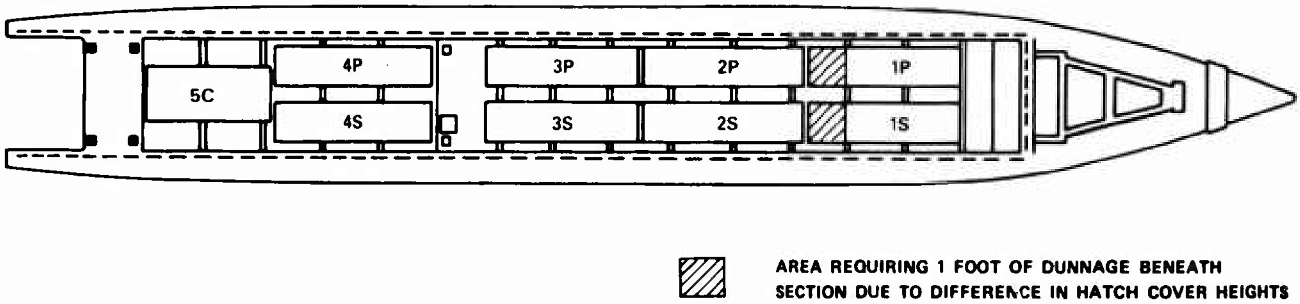


Figure 67 - Stowage Locations for Test Cargo on SS LASH PACIFICO

19 July - Load sections carrying fenders, 30-ton crane, turntable, 60-ton crane, 2 tactical causeway sections, Side-Loadable Warping Tug (SLWT), and LACV-30. Shift to anchorage at Fort Story.

20 July - Offload all loads.

21 July - Offload CLF at NSC, Norfolk.

3.3.2 LASH SHIP LOADOUT

Loadout of the LASH ship is described in the following sections.

3.3.2.1 ORDER OF LIFTS

The order in which the test items were loaded aboard the LASH ship is listed in Table 12. The stowage locations were illustrated in Figure 67.

3.3.2.2 PROCEDURES USED FOR ALL CAUSEWAY SECTION LIFTS

The procedure for all causeway lifts was to align and hold the causeway(s) under the selected slings (ports, starboard, or both) using various support

TABLE 12 - ORDER OF ONLOADING LIFTS

Order of Lift	Item*	Position Under Crane		Stowage Location
		Port	Starboard	
1	Two Pierhead Sections	X	X	1P/1S
2	Piling		X	2S
3	Bulldozer + Forklift	X		1P
4	140-Ton Crane	X		2P
5	Fenders	X		3P
6	30-Ton Crane	X		4P
7	Turntable		X	1S
8	60-Ton Crane		X	3S
9	Tactical Causeway		X	4S
10	Tactical Causeway		X	4S
11	SLWT		X	4S
12	LACV-30	Centerline		5C

*Items 2 through 8 include a causeway section on which the listed equipment is mounted.

craft. The available support craft included two Landing Craft, Mechanized (LCM)-6 tender boats, one Warping Tug, and one Side-Loadable Warping Tug (SLWT). These craft maintained the causeways in position while the CLF sling system was lowered until the bottom shackles were at the causeway deck level. The craft moored to the outboard side (with respect to the side of the ship) of the causeway to avoid interference with the lowering spreader bars on the inboard side (see Figure 68). If a second support craft was available, it would tend the causeway from a position aft of the spreaders. The Navy hookup crew on the causeway then connected the shackles to the causeway lifting rings (PH-10 fittings). Each causeway required three slings per side as shown in Figure 66. The after-two slings on each side were connected to the standard causeway lifting rings which are centered on the causeway. The slightly "out of balance" load (due to the cargo C.G. forward of the causeway center) was stabilized

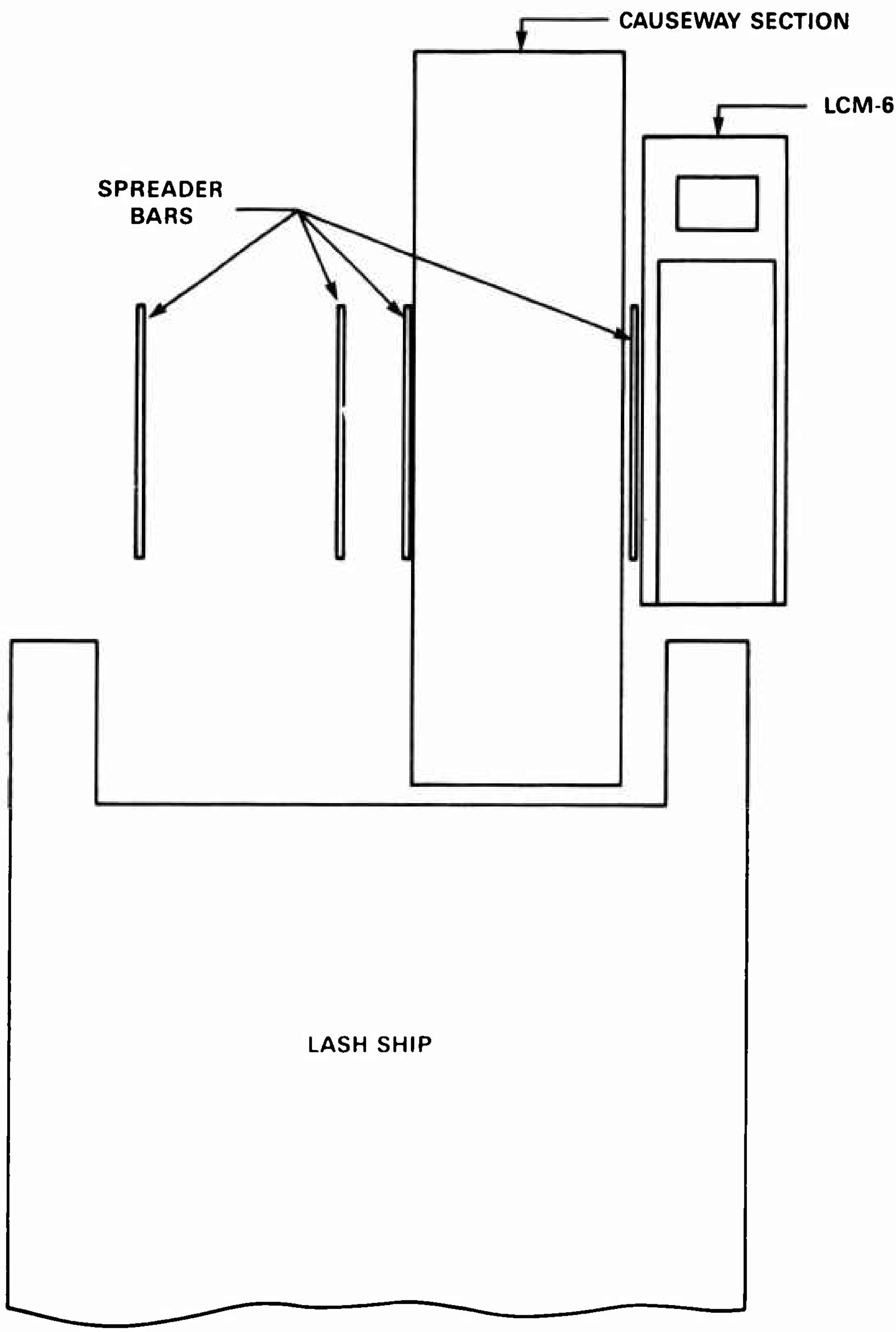


Figure 68 - Position of Handling Craft
Necessary to Avoid Spreader Bars

by the anti-rotation slings at the forward end, one per side. Once the slings were attached, the attending support craft were cast off and the load was lifted to the main deck and moved forward by the traveling gantry to the intended stow position. Before moving, the gantry crane must lift its barge lifting frame to its stops. This is its maximum lift height.

Deviations in the loadout of each causeway section occurred primarily as a result of various stacking heights and causeway load configuration. These will be discussed below on an individual basis. The LACV-30 loadout required the causeway sling system to be removed and replaced by special, self-adjusting slings.

The general procedures are summarized briefly below:

- Each item was positioned and held in the crane well by LCM-6 tender boats or warping tugs except for the SLWT which operated under its own power.
- The gantry crane then lowered the CLF enough for the slings to reach the causeway deck.
- The slings were attached to the causeway lifting rings and the anti-rotation wires to the D-rings.
- The causeway was lifted onto the ship and carried forward to its storage location.
- The gantry crane then returned to the well for the next item.

3.3.2.3 SPECIFIC LOADING PROCEDURES FOR EACH TEST ITEM

The common procedures used for each lift are described above. However, there were unique features, some planned and some not, for most of the lifts.

Several of the lifts served the dual purpose of satisfying the American Bureau of Shipping (ABS) Certification test requirements for the CLF and satisfying JLOTS II, Phase II test requirements. The ABS Certification is required for new shipboard equipment (the CLF). The ABS test requirement was to lift 110 percent of the maximum rated load (330,000 lb) and to hold it for 5 min. This had to be performed in all four of the lift configurations permitted by the CLF.

- Weight evenly divided, port and starboard, in a dual causeway lift.
- Three single causeway lifts, from the port, center, and starboard CLF lift positions.

These ABS lifts were integral with the first two JLOTS II test lift configurations.

Lift 1: Two ELCAS Pierhead Causeway Sections (with ABS test weights and dunnage):

The two causeway sections, lashed side-by-side, were pushed into the lift position under the crane by two tender boats, one moored to each side. Each causeway was loaded with concrete weights and wood dunnage and displaced a total of 165,000 lb. The weights were placed so the C.G. was located 3.25 ft forward of the causeway center. One of the causeway sections was fitted with several 18-in. high double bitts along one side. The test plan called for a second set of causeways to be stacked on top of these first two in the forward stowage positions on the ship. Therefore, dunnage was required on the one causeway section to provide support above the level of the bitts for stacking a second causeway.

The causeways were positioned under the crane, lifted just out of the water, and held for 5 min for ABS requirements. The lift was then continued and the sections moved to stow positions 1P and 1S as shown in Figure 69.

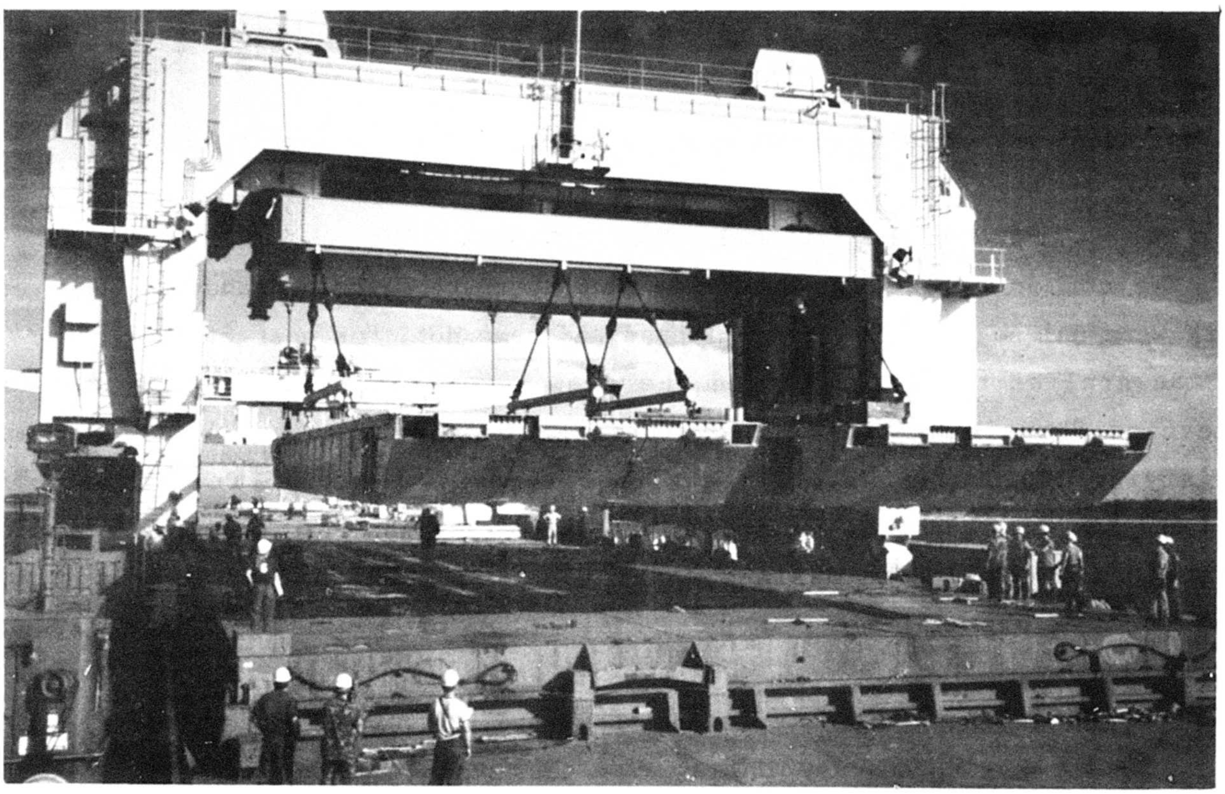


Figure 69 - Gantry Crane Transporting Two ELCAS Pierhead Sections (Lift 1)

It should be noted that the hatch cover at the 1P and 1S stowage position was elevated about 1-ft above the level of the other ship's hatch covers. Dunnage had been placed in the area under the overhang of the causeway sections to accommodate this difference.

The ship's container gantry crane removed the ABS test weights and dunnage was stacked on the starboard causeway to a height of 2 ft, approximately 6 in. above the bitts. This would allow for some compression of the dunnage when the next causeway was stacked on top.

Lift 2: Roadway Causeway Section with Piling (and additional ABS test weights)

Additional weights had been added to the causeway section with piling to bring the total lift weight up to the ABS required 330,000 lb. These weights had been positioned to move the C.G. of the total lift 3.25 ft forward of the center of the causeway. The causeway section was then lifted in the center, port, and starboard positions of the CLF. Each time the section was lifted out of the water and held for 5 min, and then put back. The third lift, starboard side, was a combined ABS and JLOTS II lift (Figure 70) and after 5 min delay, the section was lifted onto the ship.

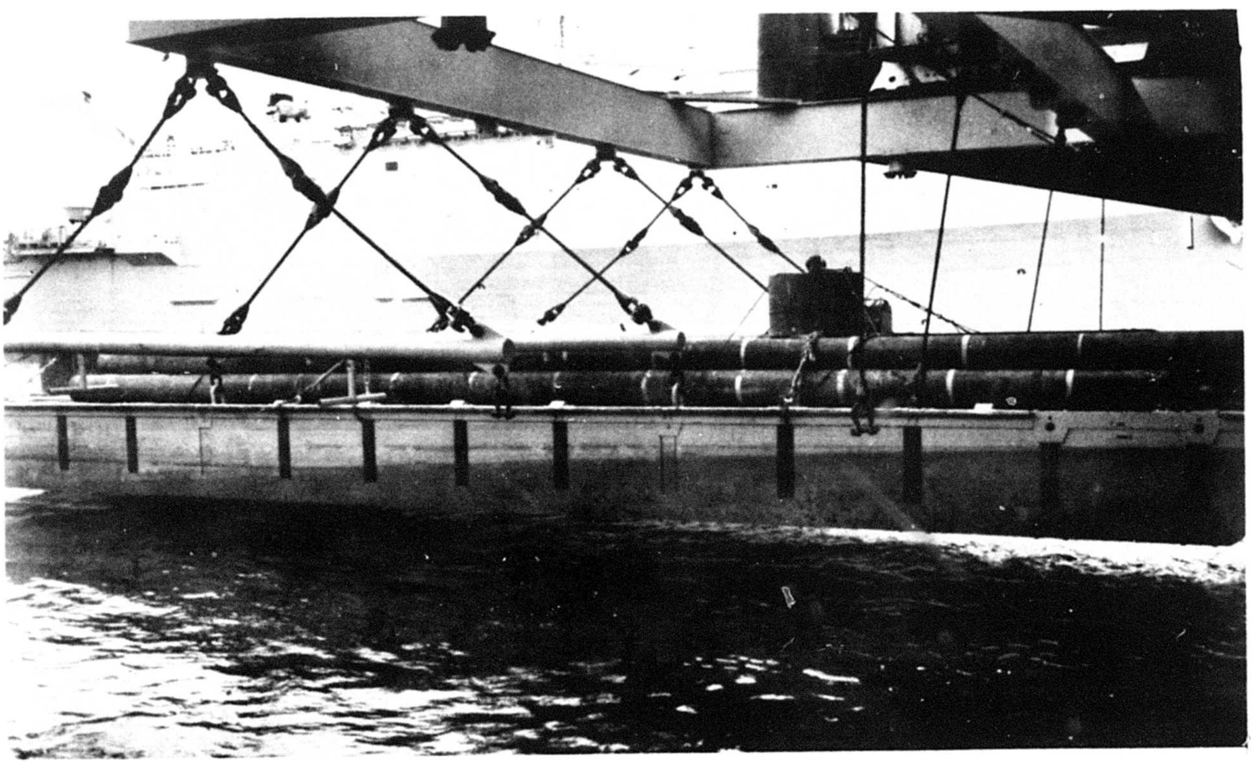


Figure 70 - Causeway Section with Piling (Lift 2)

The causeway had 33 in. of trim by the stern (relative to the plane of the hatch covers) while suspended from the CLF sling system. This occurred, to various degrees, with all loads lifted. This is discussed in Section 3.4.i.1.2. When the section was moved forward to stack it on the first section in position 1S, its after-end would not clear the 24 in. of dunnage. It was placed instead, in position 2S just aft of the first causeway.

Lift 3: ELCAS Pierhead Causeway Section with D8 Bulldozer and Super-20 Forklift

The causeway was pushed to the port side of the gantry well by a a single tender boat on its port side. The lift was performed routinely (Figure 71) and the causeway was set on 6 in. of dunnage on top of the causeway in location 1P.

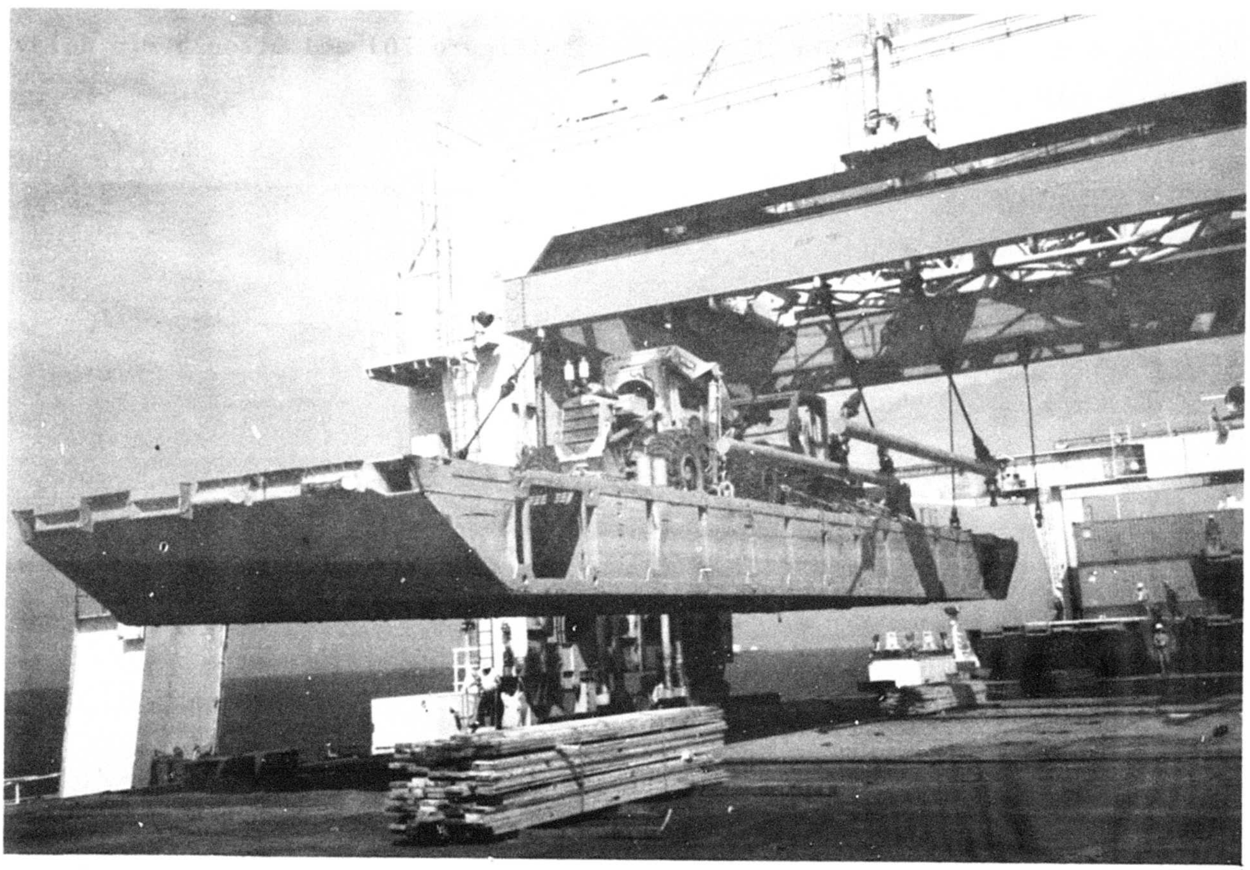


Figure 71 - D8 Bulldozer and Super-20 Forklift on ELCAS Pierhead Causeway Section (Lift 3)

Lift 4: ELCAS Pierhead Causeway Section with 140-Ton Crane

This load was brought to the ship by two tender boats and, when in position on the port side of the well, the starboard tender boat backed away to avoid contact with the lowering spreader bars. The normal procedure was followed for attaching slings and lifting the causeway onto the ship. It was stowed in position 2P just aft of the double stacked sections in 1P. The vertical clearance between the top of the 13-ft crane body and the underside of the CLF was about 1 ft when attaching the slings and 2 ft when lifted, as seen in Figure 72. The boom butt was almost level with the CLF underside. Clearances will be discussed in the analysis section.

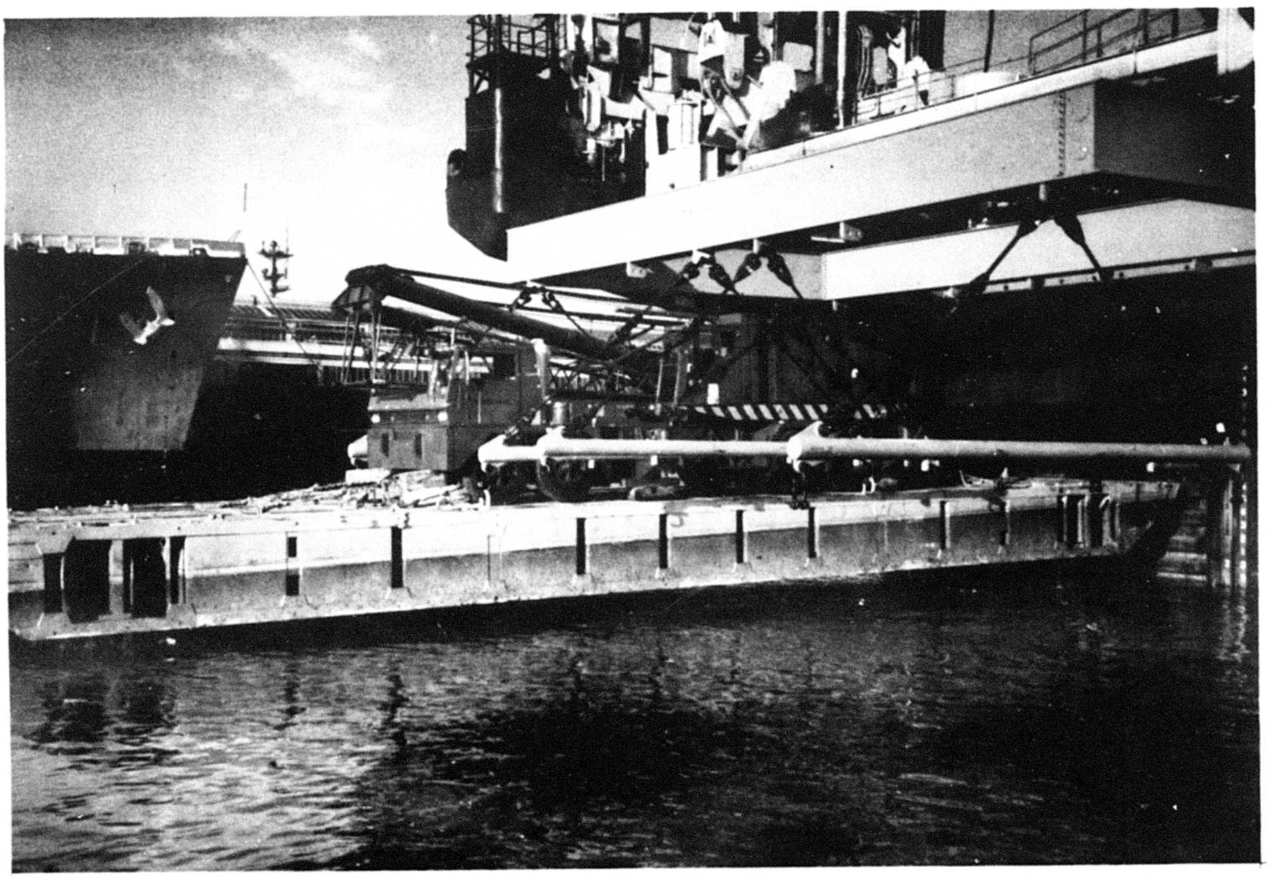


Figure 72 - 140-Ton Crane on ELCAS Pierhead Section (Lift 4)

Lift 5: ELCAS Roadway Causeway Section with Fender Units

This section was brought to the port side of the ship by the SLWT. Hookup and lift went routinely (Figure 73). After liftout, the chain plate to which the port-side anti-rotation wire was attached was bent upward about 1/2 in. The causeway was stowed in position 3P.

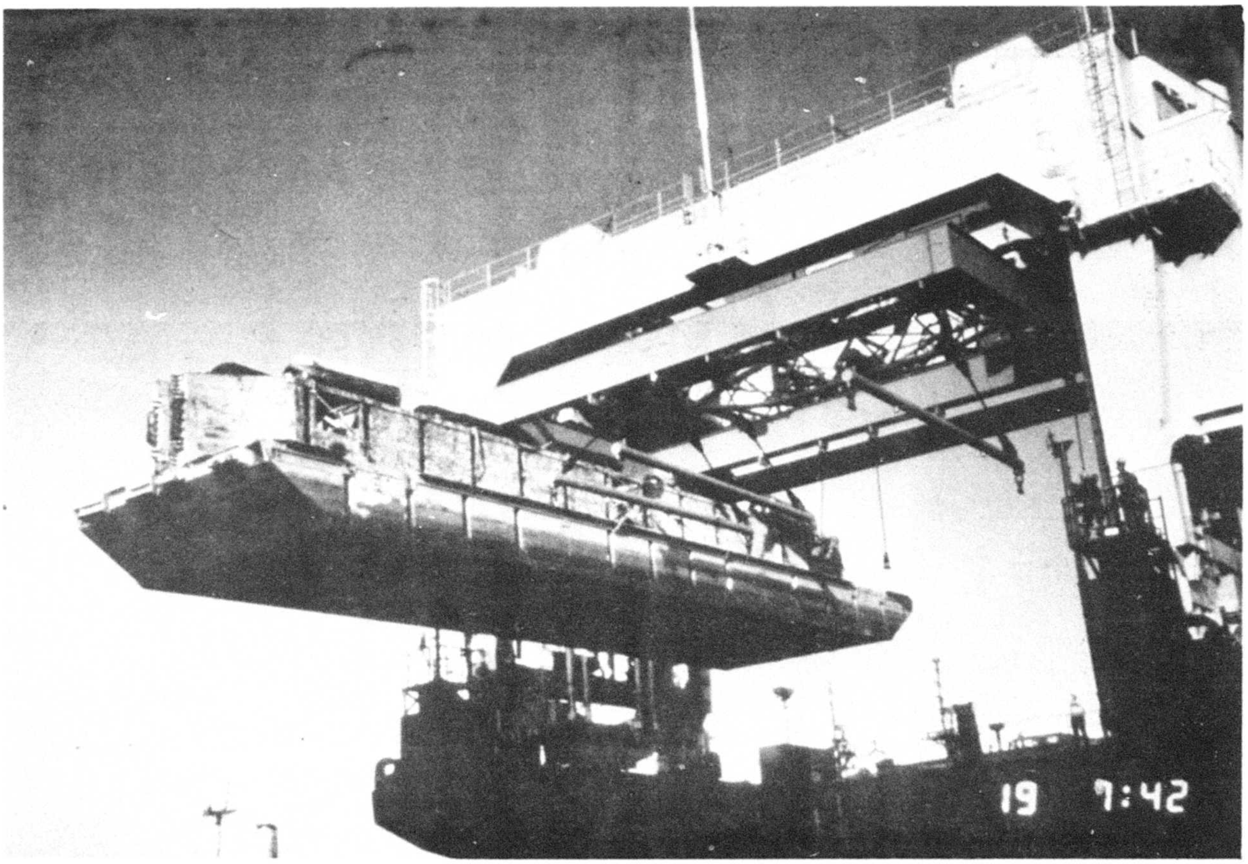


Figure 73 - ELCAS Fender Sections on Roadway Section (Lift 5)

Lift 6: ELCAS Roadway Causeway Section with 30-Ton Capacity Hydraulic Crane

The causeway was positioned in the port side of the gantry well by a single tender boat. The section was lifted (Figure 74) and stowed in position 4P with no difficulties. However, the port-side chain plate connecting the anti-rotational wire to the section bent upward about 1 in. at the location of the padeye. The clearance between the top of the crane and the underside of the CLF was about 1 ft during attachment of the slings and about 2 ft during the lift.

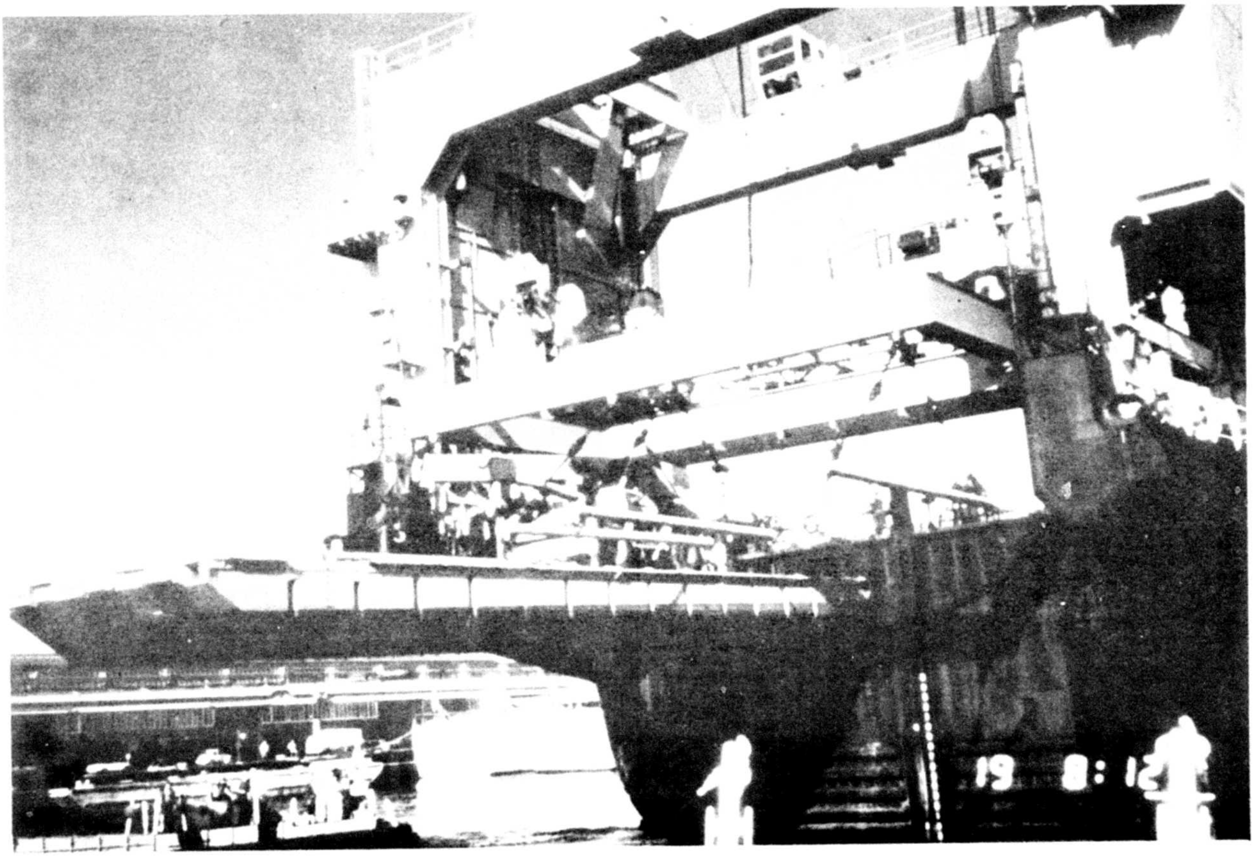


Figure 74 - 30-Ton Hydraulic Crane on Roadway Section (Lift 6)

Lift 7: ELCAS Pierhead Causeway Section with Turntable

This load was positioned by the SLWT, moored to the starboard side of the causeway and with its stern forward. The CLF could not be connected because of interference between the protruding tube for the spreader bar feet and the side assembly beams on the turntable. The beams were partially unbolted and rotated out of interference (Figure 75) and the liftout proceeded routinely. The causeway section was transported forward to place it on the section in location 1S. This was the pierhead section which included the 1.5-ft double bitts. Two feet of dunnage had been placed on this section to support the next section above the bitts. However, the section with the turntable did not clear the dunnage. It was then set on the after hatch covers for rerigging of the CLF slings to the short configuration as shown in Figure 76. After this was accomplished, the section was lifted and lowered onto the dunnage on the section in 1S. It had to be offset about 5-ft forward of the underlying section so the CLF transverse beams would bracket the bulldozer and forklift on the adjacent causeway when lowered (Figure 77).

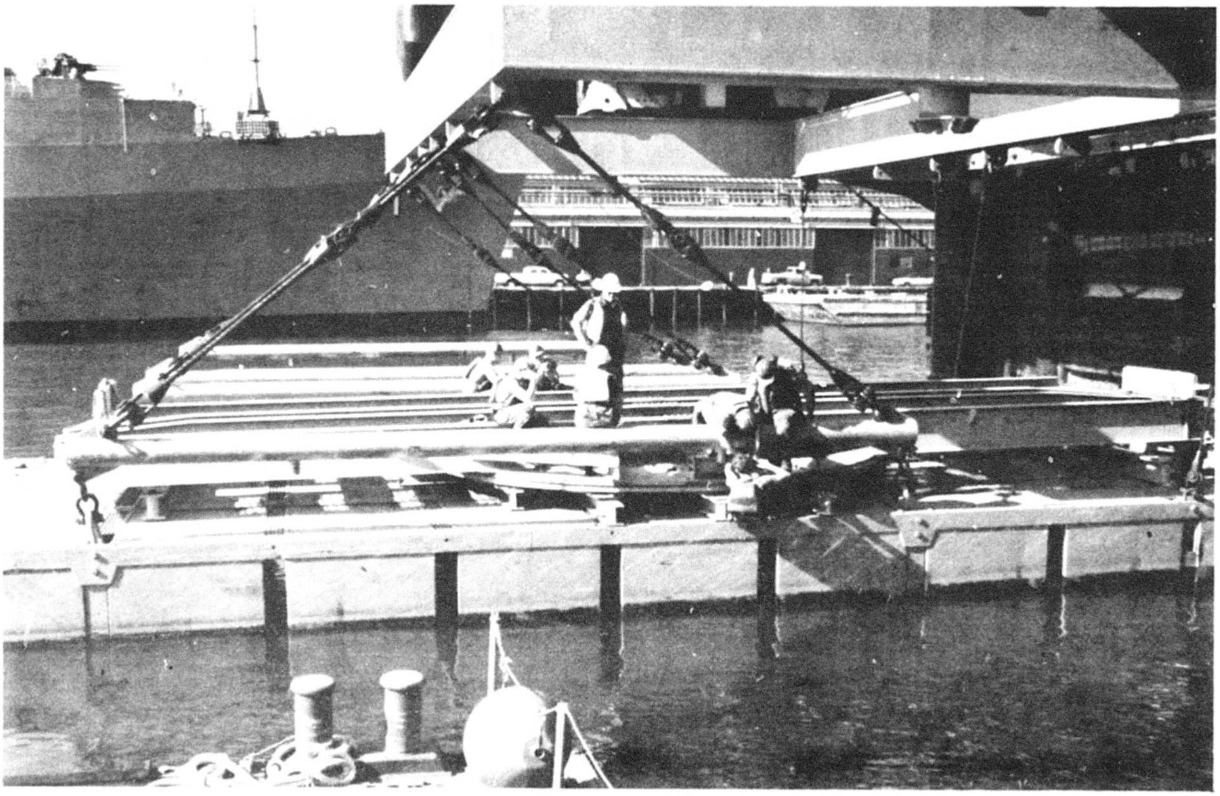


Figure 75 - Moving ELCAS Turntable Connection Beam (Lift 7)

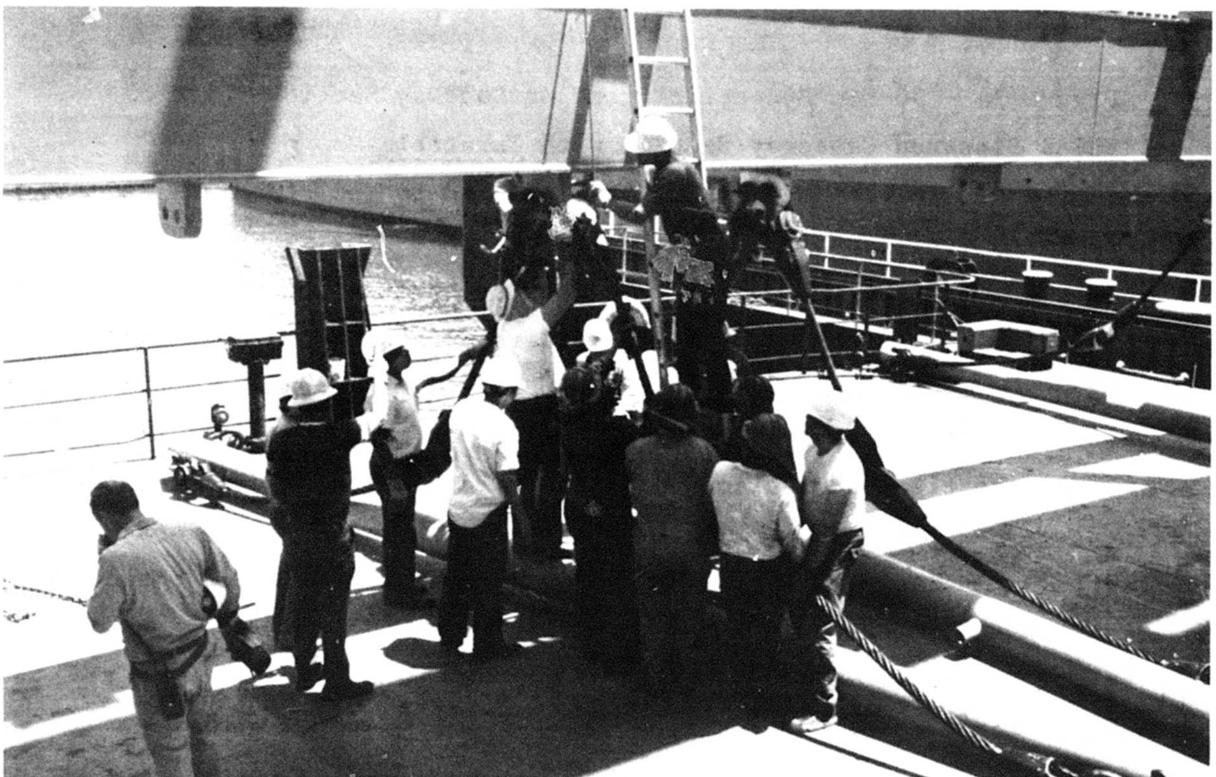


Figure 76 - Rerigging CLF Slings

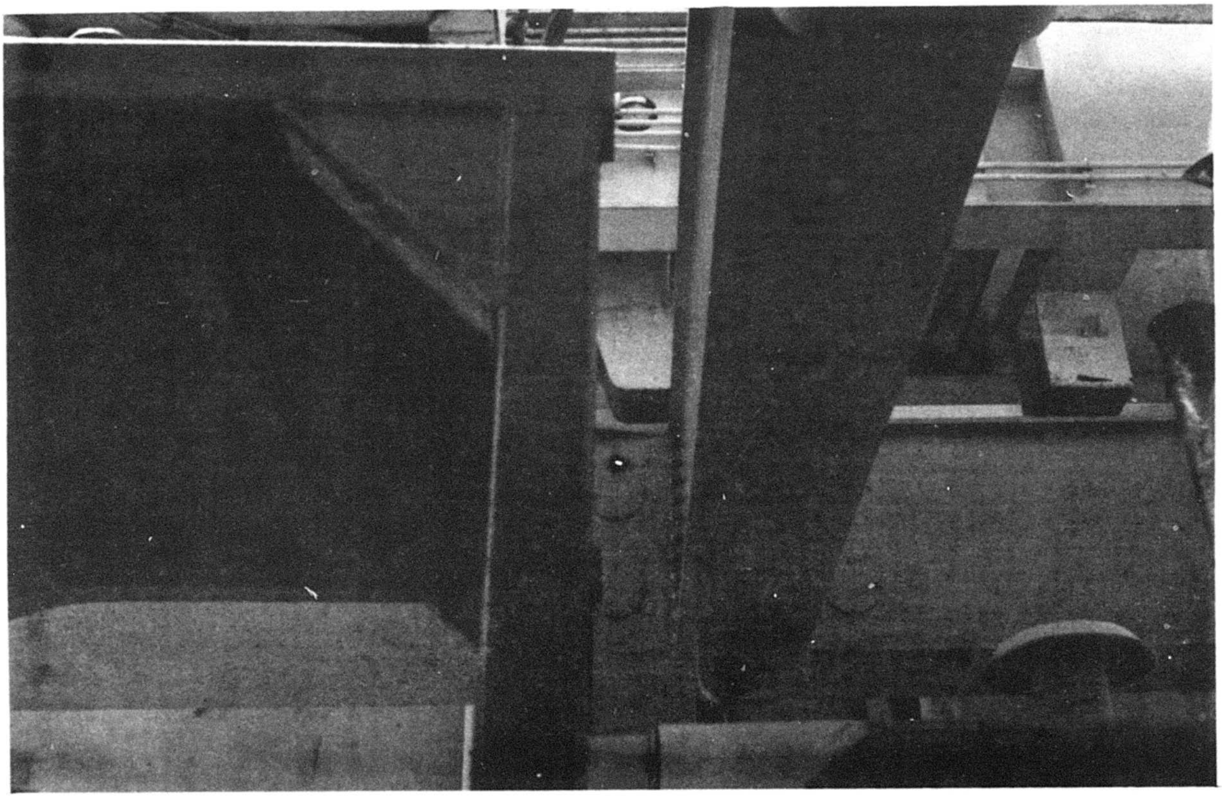


Figure 77 - Clearance between Cab of D8 Bulldozer and Forward CLF Transverse Beam

Lift 8: ELCAS Roadway Causeway Section with 60-Ton Capacity Hydraulic Crane

This causeway section was positioned by a single tender boat attached to its starboard side. When the CLF was lowered to get enough slack in the slings to attach them to the section, the main beams of the CLF were only about 1 ft above the top of the crane. When the CLF was raised to lift the section, the slack in the slings was taken out, and the clearance from the beams to the top of the crane increased to about 2 ft (Figure 78). The section was stowed in location 3S. The chain plate for the port-side anti-rotation wire connection bent upward about 1 in.

Lift 9: Tactical Causeway Section

This causeway was brought to the ship by two tender boats. The port boat departed when the section was in the starboard well position. The remaining starboard boat had difficulty maintaining position due to a slight crosswind. The section was placed in location 4S and 4- x 4-in. dunnage was distributed in stacks 2-high on its deck in preparation for stacking of the next lift.

The chain plate for the port-side anti-rotation sling connection was bent upward about 1/2 in.

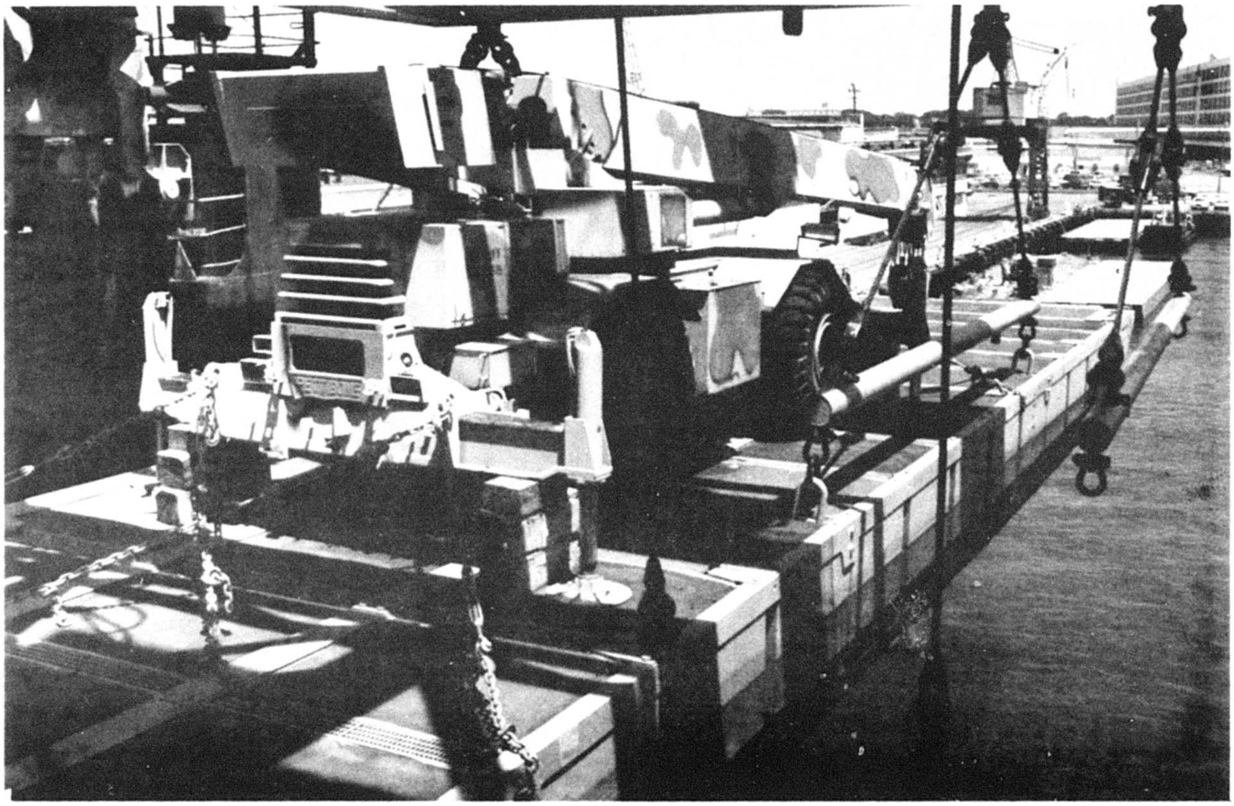


Figure 78 - 60-Ton Hydraulic Crane on Roadway Section (Lift 8)

Lift 10: Tactical Causeway Section

This section was positioned under the starboard lift position by the SLWT tied "stern to" on its starboard side. A slight breeze caused drifting to starboard, but the SLWT easily compensated for this. This section was stacked on the section in location 4S on 8 in. of dunnage.

The chain plate for the port-side anti-rotation wire connection was bent upward about 1/2 in.

Lift 11: Side-Loadable Warping Tug (SLWT)

The SLWT backed itself into the starboard lift position and slings were shackled to the craft. Some difficulty was encountered because of motion of the SLWT. Before the liftout, the engine and hatch covers were secured and the crew transferred to a tender boat.

The anti-rotation connections were improperly located approximately 44-in. forward on the SLWT assembly angles as indicated in Figure 79. This reduced the support available to the angle and increased the load which resulted in a 1-in. yielding of the starboard angle.

Slings were rerigged to the short legs to lift the SLWT onto the two sections stacked in location 4S (Figure 80). Lashing of the stacked sections

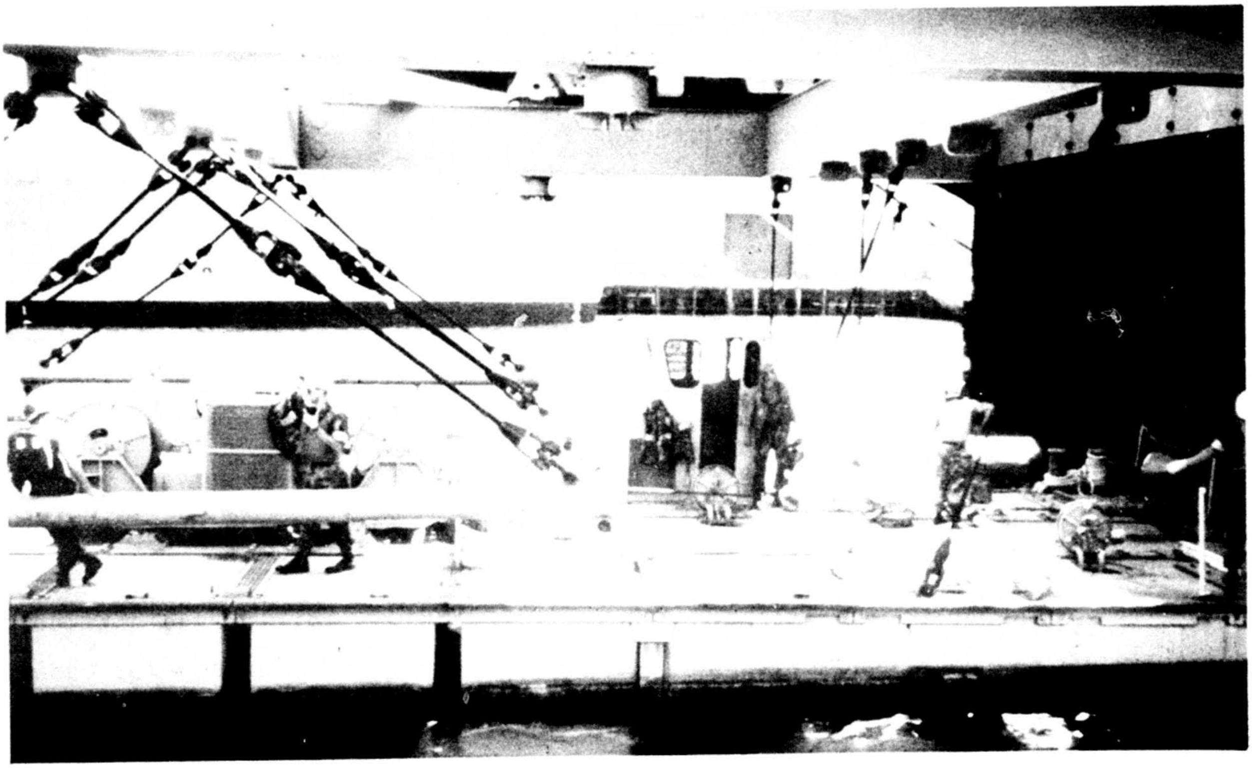


Figure 79 - Side-Loadable Warping Tug (SLWT) with Improperly Located Attachment Points for Anti-Rotation Wires (Lift 11)

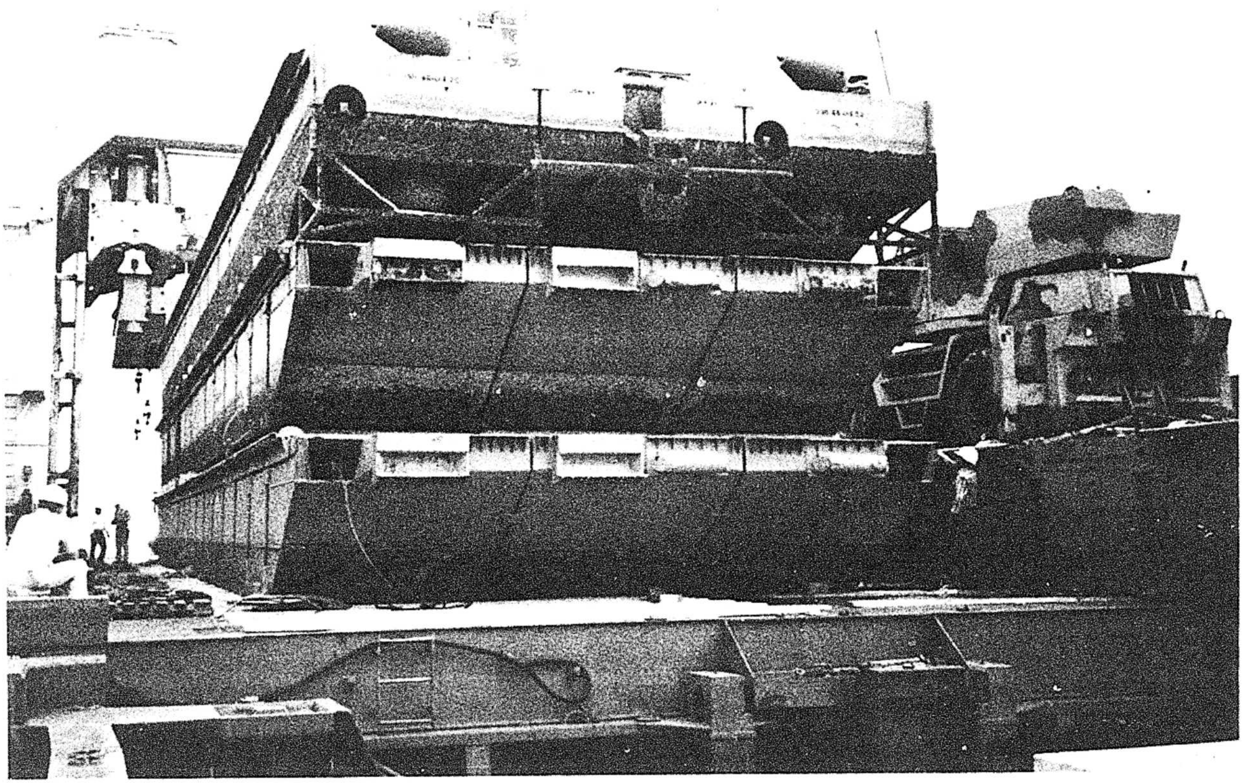


Figure 80 - SLWT Stacked on Two Tactical Causeway Sections

(Two tactical causeways and one SLWT) for storm sea conditions was not completed. The materials used and the reasons for stopping are discussed in the analysis section.

Lift 12: Lighter, Air Cushion Vehicle, 30-Ton (LACV-30)

The inboard port and starboard spreaders and slings were removed from the CLF to accommodate installation of the special LACV-30 self-adjusting lifting slings.

The craft was positioned bow-forward under the crane by a tender boat tied to its starboard side. When the gantry crane was lowered to the bottom of its guides the CLF was about 9-ft above the LACV-30 deck. The craft's crew attached one of the slings to the CLF by heaving a line over the transverse beam and hauling the sling up to its intended padeye (Figure 81). This proved difficult and dangerous, so the second sling was lifted to the deck of the ship for easier attachment to its CLF padeye. See Figure 82 for the sling configuration. The CLF, with slings attached, was again lowered for hookup.

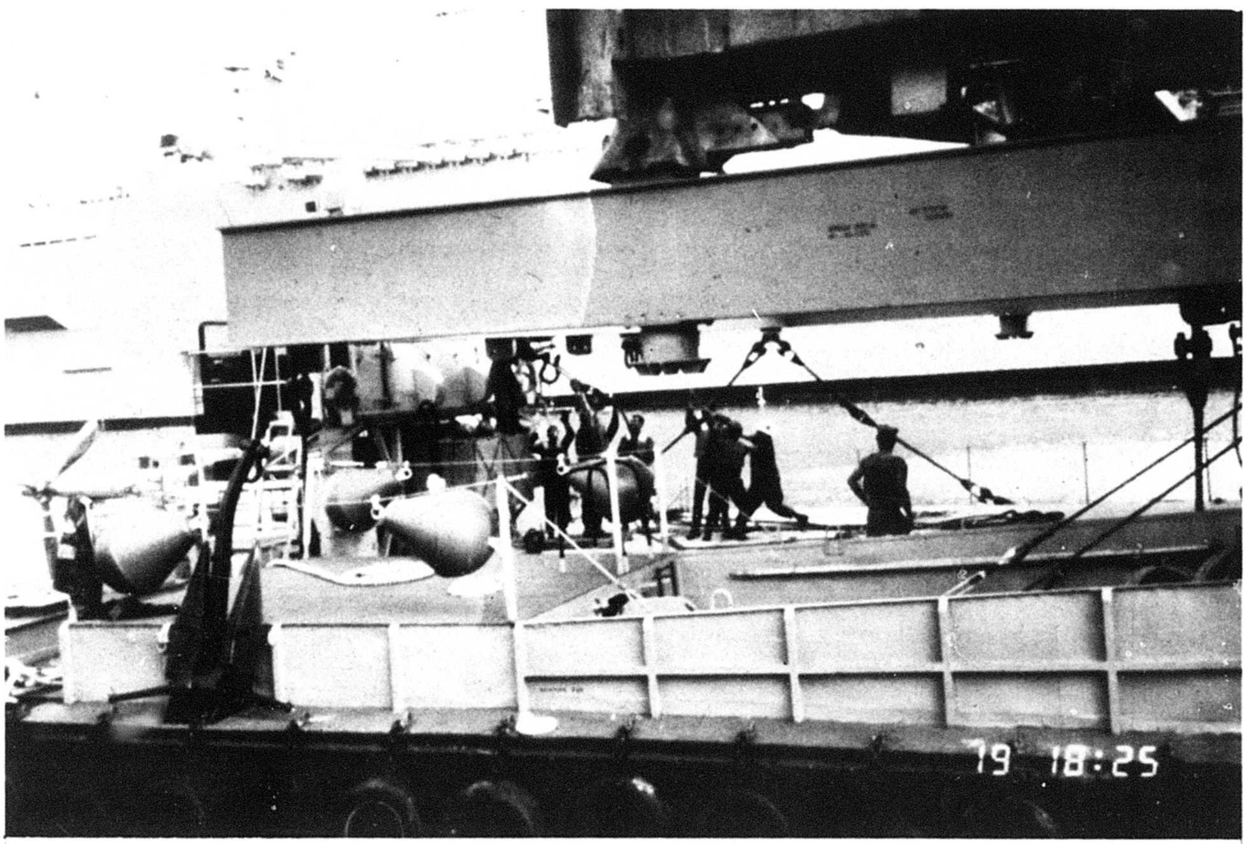


Figure 81 - Attaching LACV-30 Sling to CLF from the Deck of the LACV-30

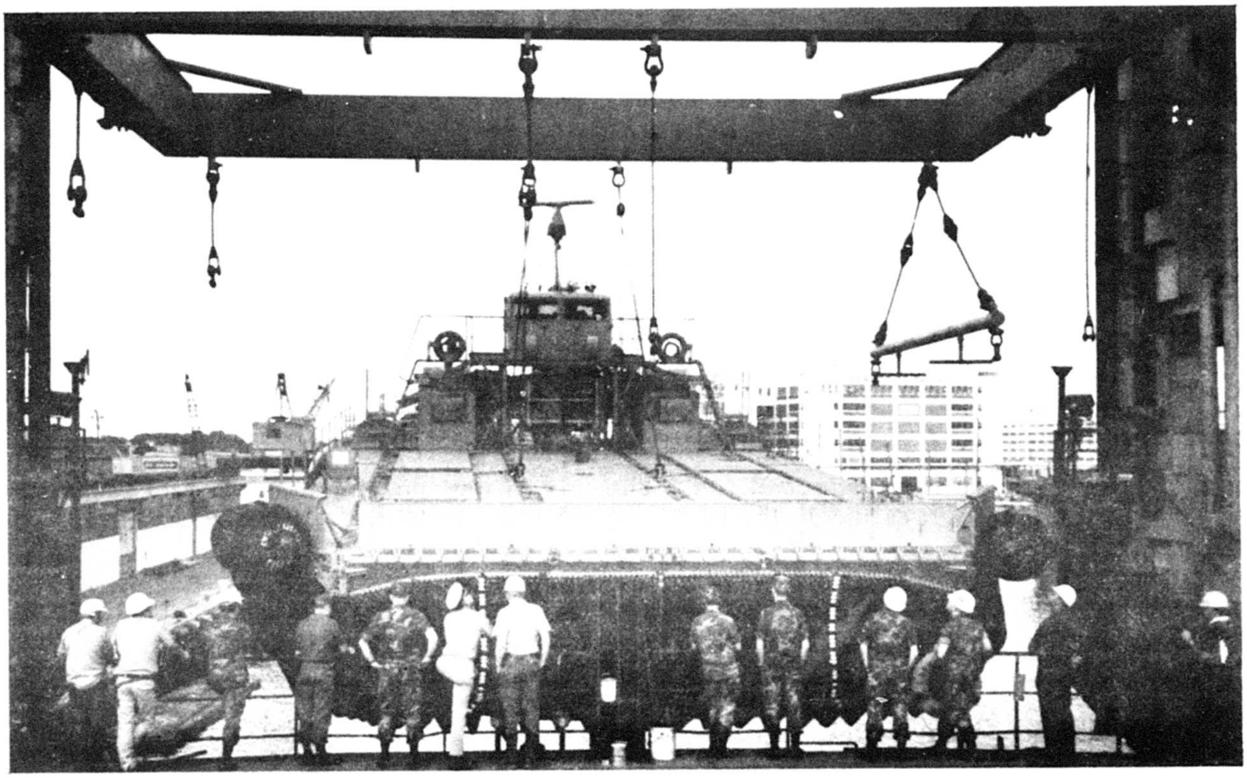


Figure 82 - First Lift of LACV-30 (Lift 12)

The craft was lifted clear of the water and held to allow water to drain from its cushion seals. When lifted to deck level it had a 7-ft trim by the bow and its longitudinal axis was not parallel with the ship's. The bow trim caused a 3-ft interference between the bow seal and the vertical barge alignment post projecting above the transom (see Figure 82).

On the suggestion of the LACV-30 crew, the craft was lowered into the water and the slings readjusted themselves with a resulting 13-in. trim by the stern. Although it was still not aligned with the ship's centerline, it cleared the transom (16-in. clearance forward and 3-in. aft), and was placed on the ship's after hatch cover on plywood sheets under its landing pads. Prior to setting it down attempts were made to align it longitudinally but with no success.

3.3.3 LASH SHIP OFFLOAD

3.3.3.1 GENERAL

The offload procedure was simply a reverse of the loading procedure. The lessons learned during the loadout were reflected in the continued improved performance of both military and ship's crew during the offload. The general procedures are summarized below:

- The gantry crane with CLF was moved over the item to be lifted and the slings were attached.
- The item was lifted, transported aft to the ships crane well and lowered into the water until the slings were slack.
- A lighter (tender boat or warping tug) moored alongside and the Navy crew transferred aboard the section.
- Slings were disconnected and the item was pulled away from the gantry well.
- The causeway sections were end-connected into groups of 2 or 3 for transit.

3.3.3.2 ORDER OF OFFLOADING

The order of offload of test items is listed in Table 13.

3.3.3.3 SPECIFIC OFFLOADING PROCEDURES FOR EACH CARGO ITEM

Lift 1: LACV-30

The gantry crane had been stowed over this load with the LACV-30 slings still attached. The slings were connected, and the LACV-30 was lifted, transported aft, and lowered to the water with no difficulty.

When set into the water, the craft started to rotate and shift to starboard (Figure 83). The CLF was raised slightly and the tension on the slings straightened the craft. The LACV-30 crew transferred to the craft from a warping tug. While the crew started the engines, the CLF was lowered and the craft again rotated nearly 90 deg in the well. The slings were disconnected, power was applied, and the craft pulled clear of the ship without further incident. The slings were removed from the CLF to the deck of the ship.

Lift 2: Side-Loadable Warping Tug (SLWT)

Lashings had been removed from the SLWT and the two tactical causeway sections on which it was stacked during the LACV-30 offload. The CLF, rigged with short slings, lifted the SLWT off the stack and placed it on the after hatch covers. While the long slings and spreader bars were rerigged, the anti-rotation wire D-rings were relocated (see Lift 11, page 98). The

TABLE 13 - ORDER OF OFFLOADING LIFTS

Lift	Item*	Position on Ship Port	Position on Ship Starboard
1	LACV-30	Centerline	
2	SLWT		X
3	Tactical Causeway Section		X
4	Tactical Causeway Section		X
5	60-Ton Crane on ELCAS Roadway Section		X
6	30-Ton Crane on ELCAS Roadway Section	X	
7	ELCAS Fenders on Roadway Section	X	
8	140-Ton Crane on ELCAS Pierhead Section	X	
9	Piling on ELCAS Roadway Section		X
10	D8 Bulldozer and Forklift on ELCAS Pierhead Section	X	
11	ELCAS Turntable on Pierhead Section		X
12	2 ELCAS Pierhead Sections	X	X

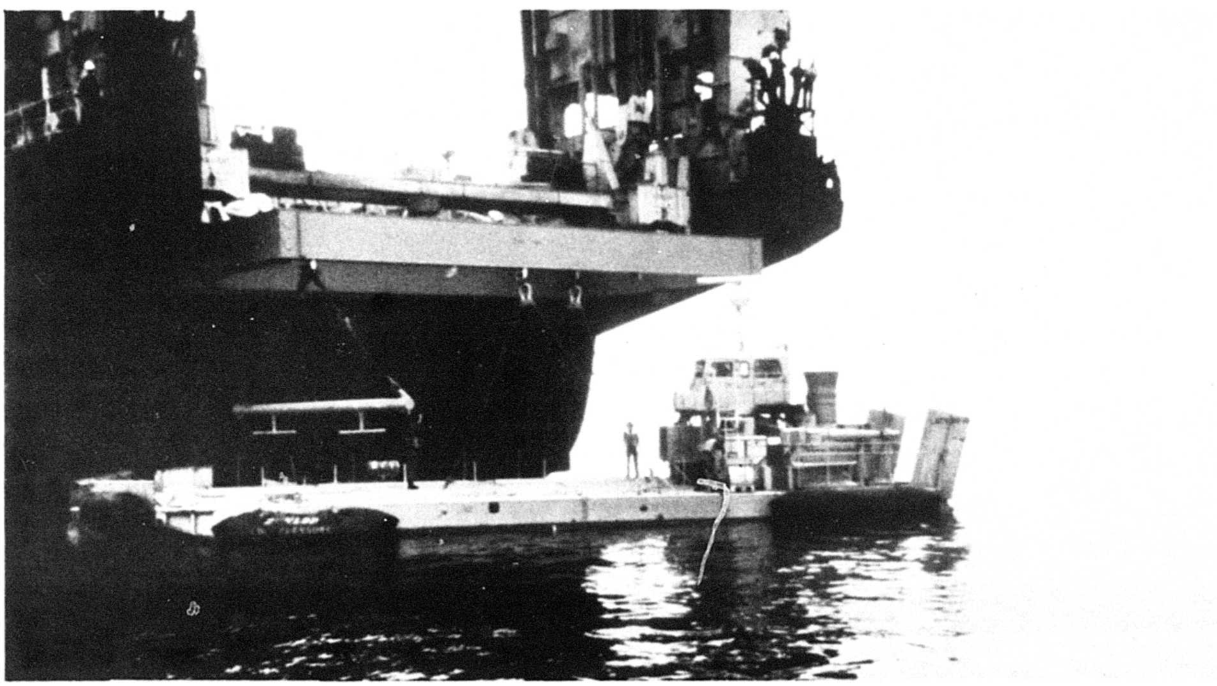


Figure 83 - LACV-30 Rotated While Starting Engines

remainder of the launch went smoothly and the SLWT crew boarded from a warping tug. The craft departed under its own power.

Lift 3: Tactical Causeway Section

This offload was routine. A warping tug was end-connected to this section before the slings were disconnected (Figure 84).

Lift 4: Tactical Causeway Section

This section was held in place in the well by the slings until end-connected to the previous section and warping tug. When slings were disconnected, the two sections were pulled from the well and transferred to the SLWT.

Lift 5: ELCAS Roadway Causeway Section with 60-Ton Crane

This offload went routinely except for momentary interference between tender boat and spreader bars.

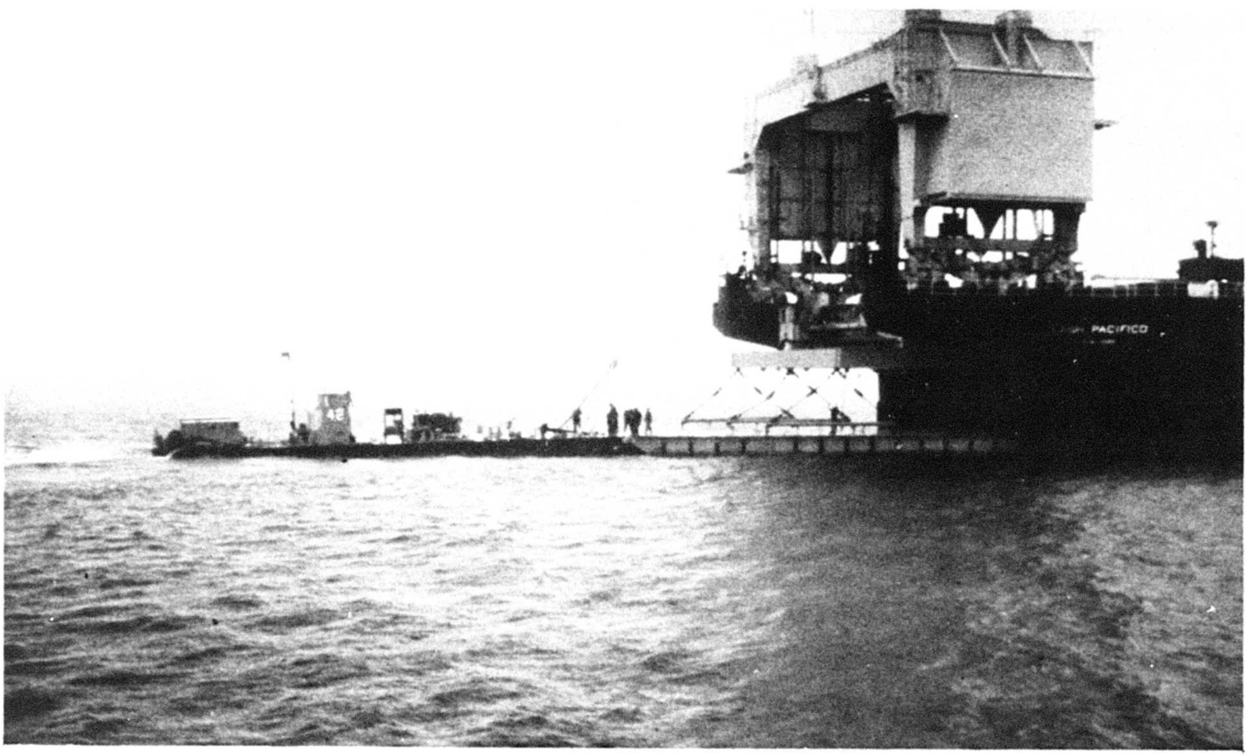


Figure 84 - End-Connecting Warping Tug to Tactical Section

Lift 6: ELCAS Roadway Causeway Section with 30-Ton Crane

When this load was placed into the water, an attempt was made to end-connect it with the 60-ton crane section as shown in Figure 85. The attempt was unsuccessful and the two sections were independently pulled away and connection was completed clear of the ship.

Lift 7: ELCAS Roadway Causeway Section with Fender Units

Increased motion because of wind and swells caused some difficulty in disconnecting the sling shackles. This section was then used to demonstrate backloading (see backloading section) after which it was end-connected to the 30-ton and 60-ton crane sections for transit.

The spreader bar feet were removed to reduce interference with this load. The pins and feet had to be removed with hammers because they had been damaged.

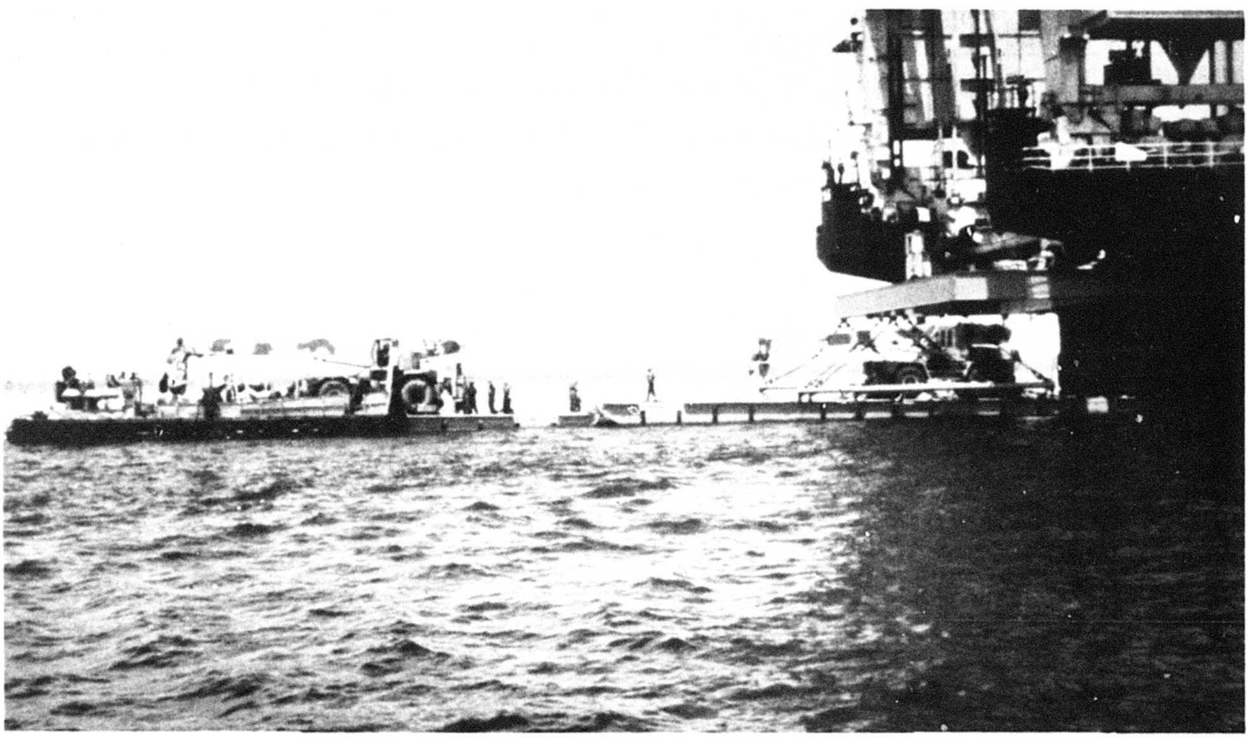


Figure 85 - Attempting to End-Connect Causeway Sections Carrying 60- and 30-Ton Cranes

TABLE 15

SUMMARY OF ENVIRONMENTAL CONDITIONS DURING LASH OFFLOADING/BACKLOADING OPERATIONS

DATE	20 JULY 1984								
TEST EVENT	LAC-V -30 Moved & Launched	CAUSEWAY SECTIONS MOVED & LAUNCHED BACKLOAD OF CAUSEWAY LOAD NO. 5 (1430 - 1500)							
TIME OF DAY	0900	0940	1030	1130	1240	1400	1530	1700	1830
Wind-Speed (kts)	5-10	10	10-15	10-15	10-15	10-15	15-20	15-20	10-15
- Direction	ENE	E	E	E	ESE	SE	S	S	S
Temperature Air-deg F	72	72	72	72	72	77	77	75	72
Precipitation	Dry	Rain	Rain	Dry	Heavy Rain	Dry	Dry	Dry	Dry
Visibility	Cloudy	Cloudy	Cloudy	Cloudy	Cloudy	P-Cloudy	P-Cloudy	Clear/ Sunny	Clear/ Sunny
Wave-Significant Hgt (ft)	1/2 - 1	1/2 - 1	1/2 - 1	1/2 - 1	1 - 2	1/2 - 1	1/2 - 1	1 - 1-1/2	1/2 - 1
- Direction From	ENE	E	E	E	ESE	SE	S	S	S
Current E-Ebb, F-Flood (kts)	1/4E	1/4E	0	1/8F	1/4F	1F	1-1/4F	1F	1/2F
Ship Motion/ Heading									
- Roll (deg)	1/4	1/2	1/4	1/4	1/4	1/4	1/4	1/4	1/4
- Pitch (deg)	0	0	0	0	0	0	0	0	0
- Heading (deg)	290	313	350	60	103	100	105	105	105

3.4.1.1 EQUIPMENT

Test cargo, support equipment, and ship equipment are treated in that order.

3.4.1.1.1 TEST CARGO

In the SEABEE Deployment Test, each test item was unique except for the pair of LARC-LX's. In the LASH Deployment Test, all of the causeway sections and the SLWT were lifted using the same slings and attachment points. The LACV-30 was the only unique item lifted. The causeway sections carried a variety of cargo (or no cargo) as listed in Table 11. The cargo and the majority of causeway sections are components of the Elevated Causeway System (ELCAS). The first lift involved two side-by-side, empty causeway sections utilizing both port and starboard sides of the CLF. All remaining causeway lifts used one side or the other. The LACV-30 was lifted from centered padeyes on the CLF and with its own, specialized slings. Unique features or problems are discussed below.

Equipment to Causeway Lashing

The lashing hardware used by the owning unit for the equipment on the sections were standard chain and turnbuckles which are currently in the Navy supply system. The chain is wrapped around the causeway assembly angles on one end and connected to a vehicle tiedown padeye or wrapped around the vehicle axle on the other end (Figure 87). A turnbuckle is included in the middle to provide for tightening of the chain. Wheeled vehicles are blocked up on dunnage before lashing. Placing the equipment on the causeway section and installing the tiedowns is a long slow process which requires several weeks to plan and perform. This process is discussed in the Procedures section (3.4.1.2).

Causeway Section Damage

The causeway sections and the SLWT were lifted using their standard causeway lifting rings (Figure 88) and anti-rotation wires attached to D-rings (Figure 89) which were welded on the forward end of the section. The D-rings were positioned on assembly angles between the assembly bolts of two adjacent pontoon cans since these bolts provide the stiffness needed to prevent bending of the assembly angles.

On the sections carrying the 30-ton crane, the fender units, the 60-ton crane, and the two empty tactical sections, a CP-1 chain plate had been installed in this location, and the D-rings were installed on top of the chain

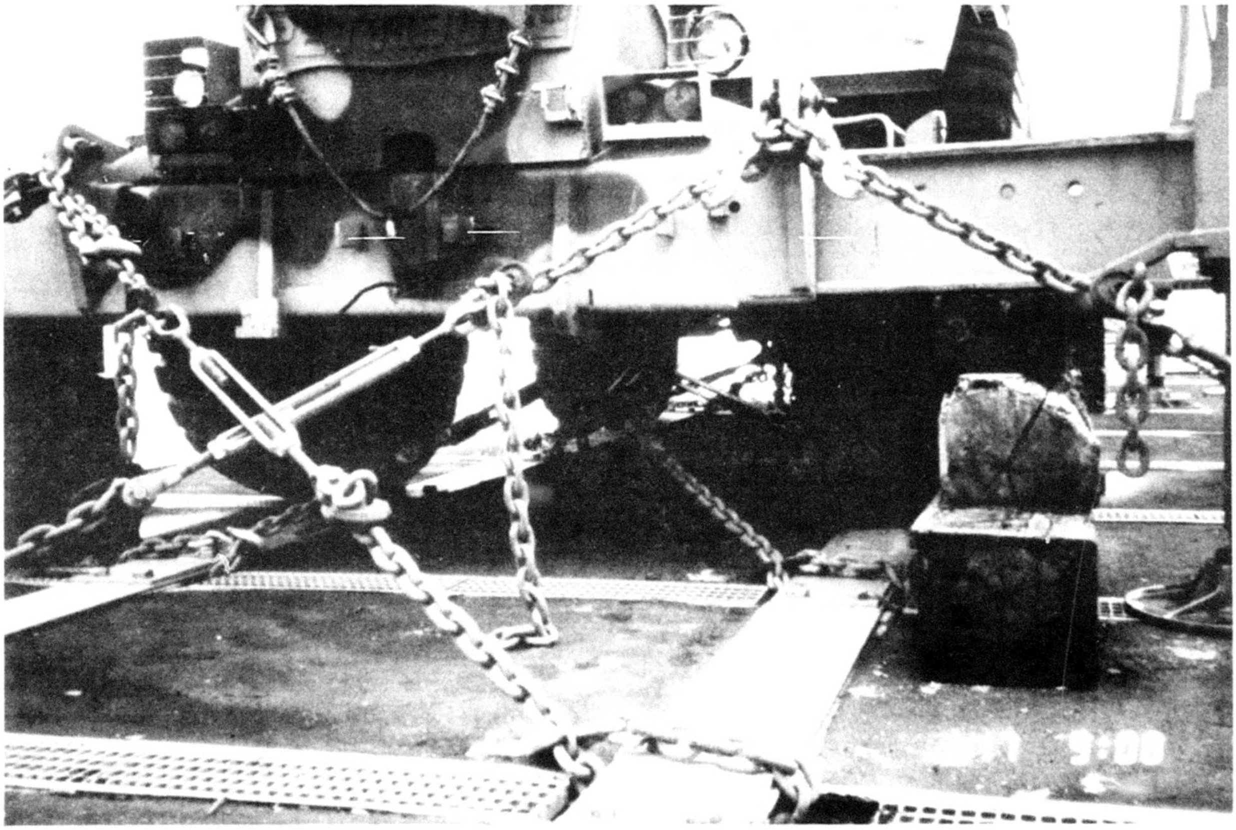


Figure 87 - Typical Lashing Configuration

Figure 88 - Connecting Spreader Bar Shackle to Causeway Lifting Ring

Figure 89 - Connecting Anti-Rotation Wire to D-Ring

plates. The installation of the chain plates includes welding the main portion to the assembly angle fore and aft of the bolts and on top of the cans which it overlaps. On the causeway sections starboard side, a launch angle strengthens the chain plate (Figure 90). The outside edge of the port-side chain plate was not welded, however, and it was this edge that was pulled up during lifting of these sections (Figure 91).

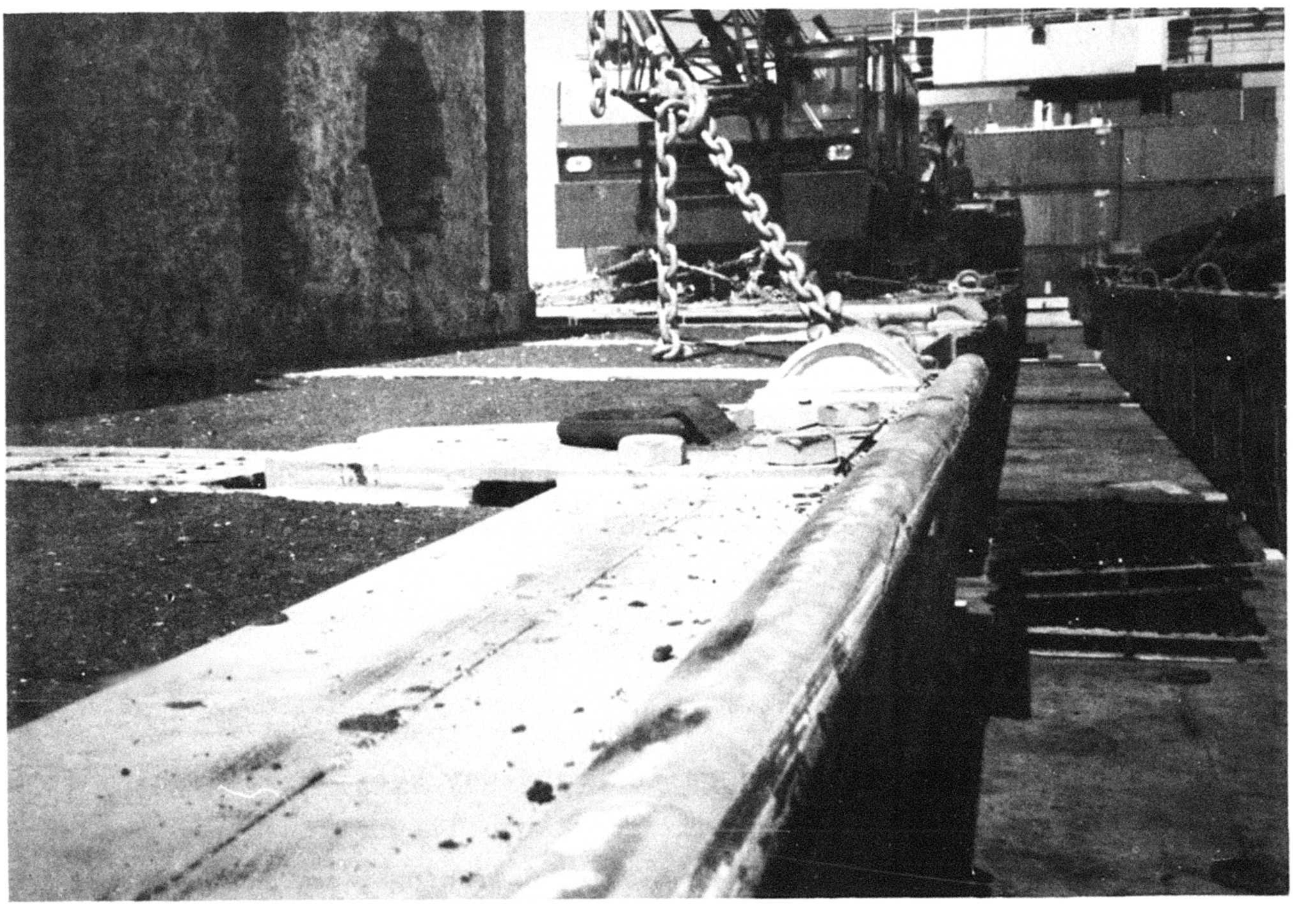


Figure 90 - Starboard-Side Chain Plate Installed on Causeway Section. (Note: Adjacent launch rail)

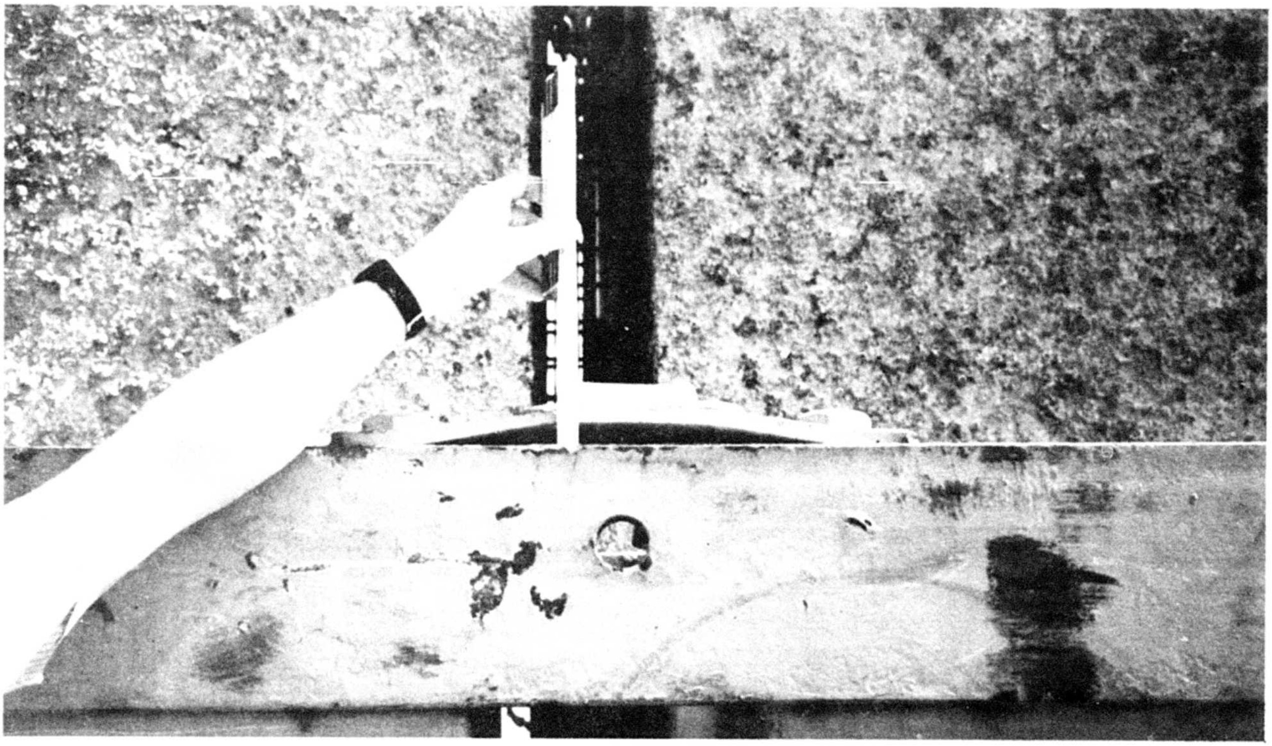


Figure 91 - Port-Side Chain Plate Bent Along Outside Edge Where Not Welded to Assembly Angle

SLWT Damage

The D-rings on the SLWT were welded onto the assembly angles about 44 in. out of position. This placed them about midway between a pair of bolts which are approximately 50-in. apart. Over this span the assembly angle is not sufficiently braced to withstand the forces incurred in lifting the SLWT. The entire starboard assembly angle bent upward about 1 in. with the inside edge bending upward about 2 in. (Figure 92). The port angle was bent up along the outside edge about 1 in..

3.4.1.1.2 SUPPORT EQUIPMENT

Lash Loadout Computer Program

The equipment was positioned on the causeway sections according to a computer program which takes into account the capability of the ship's gantry crane, the weights of the equipment, sections and lashings, and the expected sea state during loading and offloading. This program was provided to the Naval Amphibious Construction Battalion as part of the draft Loading Manual for LASH Vessel and used under the guidance of Naval Civil Engineering Laboratory (NCEL) and David Taylor Naval Ship R&D Center (DTNSRDC) personnel. Several problems

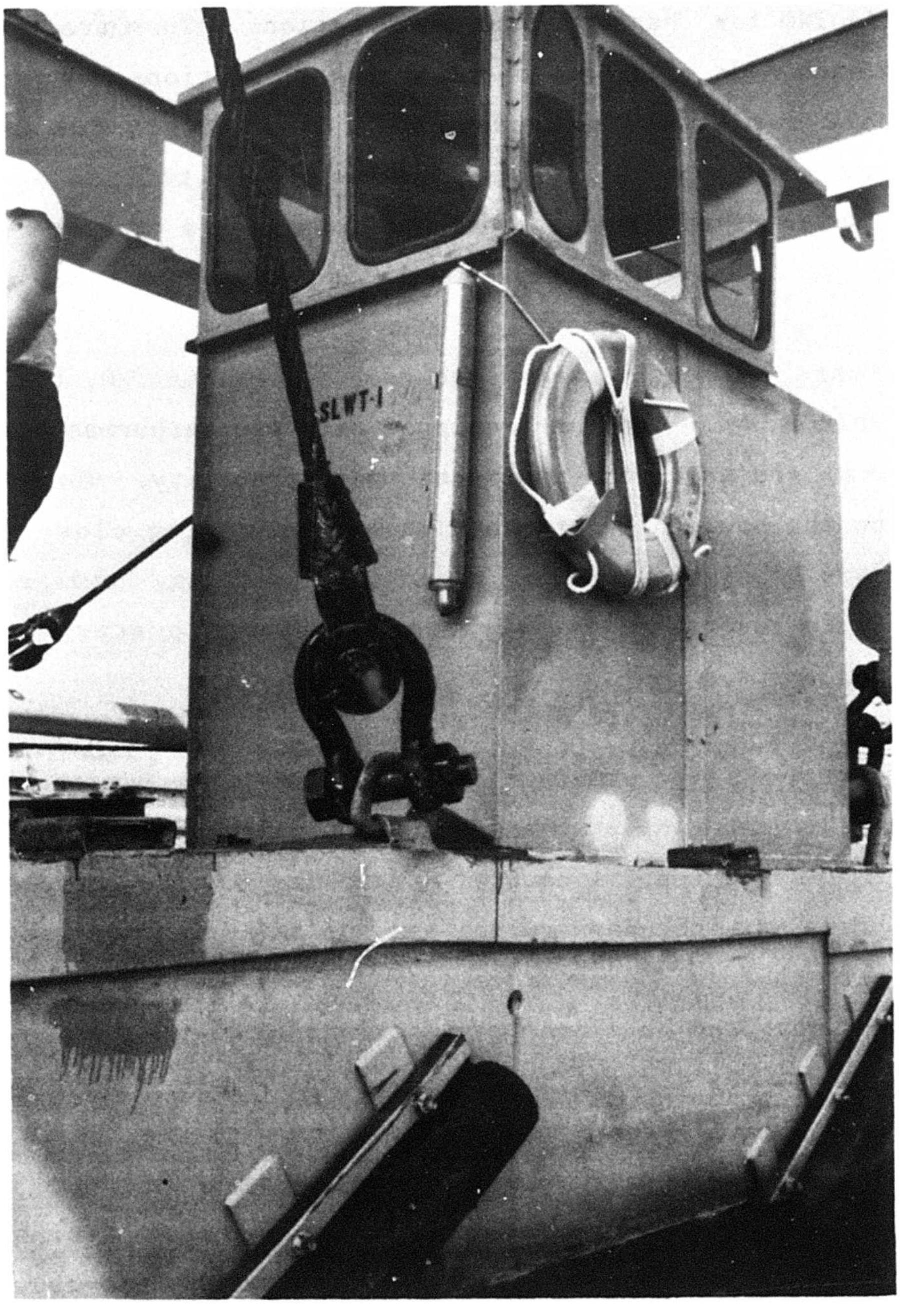


Figure 92 - Damage to SLWT Assembly Angle

were found to exist and the program was modified several times during the loadout of the sections. Work is continuing to modify the program and instruction manual according to the lessons learned during the loading of equipment on the sections. The process of planning and performing the loading of the causeways is discussed in the Procedures section below.

LCM-6 Tender Boats

These craft are currently used extensively by Amphibious Construction Battalion (PHIBCB) TWO for handling causeway sections. They are commonly used in pairs, one on each side of a section or string of sections. It appeared that they were adequate for handling causeways in open water, but did not have adequate power or maneuverability when operated one to a section in close proximity to the ship. This was especially obvious when a cross current or wind was present.

Warping Tugs

These craft are currently used in homeport by PHIBCB TWO, and in homeport and overseas by PHIBCB ONE. They are equipped with two Harbormaster propulsion units above decks, and have good power and maneuverability. They are equipped with an A-frame on the bow, which prevents them from coming close to the ship bow-first. This was not found to be an operational problem, however, since they have good mobility in reverse and simply came to the ship stern-to or stayed back from the ship.

Side-Loadable Warping Tug (SLWT)

The SLWT (Figure 79) is similar in shape and construction to a causeway section except that it has two waterjet propulsion units with rotating nozzles built into its stern modules. A control station is mounted above decks on the starboard side. The SLWT includes a winch and has an A-frame on the bow.

The waterjet propulsion provides very good power and maneuverability which allows the craft to move and hold causeway sections in tight spots.

Cantilever Lift Frame (CLF) Rigging

The main support for lifting a causeway section with the CLF is provided by the slings/spreader bar arrangement (Figure 65). The spreader bar is approximately 29-ft long and connects to the causeway's lifting rings by 2-in. shackles. Slings connect the spreader bar ends to a single two-hole padeye on the CLF.

The geometry of a causeway section suspended by slings from the CLF, with the CLF point over the longitudinal center of the section, allows minimal clearance between the ship's transom and the forward end of the causeway section. If the C.G. of the loaded causeway was aft of the longitudinal center, the suspended load would rotate, resulting in reduced clearance or contact at the transom. Additionally, the maximum allowable load on the CLF (300,000 lb), if centered directly under the CLF lift point, would overstress the locking pins which connect the CLF to the aft attachment points of the gantry crane's Barge Lifting Frame. The solution to these two situations is to purposely load the causeway section so that its C.G. is forward of its longitudinal center and restrain it from rotating by using a pair of vertical pendants attached to the forward portion of the causeway section and to a member of the CLF structure directly overhead.

As the weight of the lift approaches the 300,000 lb maximum, the C.G. must be moved forward to prevent overloading the aft pins connecting the CLF to the crane. However, the amount that the C.G. can be moved forward is limited by the characteristics of the cargo items, the strength of the anti-rotation slings, and the orientation of the causeway section when floating (a minimum of one foot of freeboard is required). These limits are taken into account by the load planning computer program and loading procedure discussed in Section 3.4.1.2.

The CLF is equipped with padeyes for lifting causeway sections in three positions; port, starboard, and center. There were two sets of slings provided with the CLF and these were normally attached to the port and starboard sets of padeyes.

The slings/spreader bar arrangement provide the gantry crane with the capability to lift a section from the water and to transport it to its designated storage location on the ship. Within the dimensional limits of the gantry cranes, the height to which the section can be lifted is limited by the length of the slings. Under normal conditions, there is sufficient height in the lift so that causeways can be stacked two-high without rerigging to short slings. This is discussed in Section 3.4.1.2.

If a causeway cannot be stacked because of an interference, short slings must be used. The long slings connecting the spreader bars to the CLF are made of two parts. The four short slings are obtained from the upper part of each of the two-part slings attached to the spreader bars. The short slings are used only for stacking causeways and cannot be used for lifting them from/to the water.

The spreader bar has feet, made of pipe, for resting the spreader bar on the causeway deck during connection/disconnection of shackles to causeway fittings. The feet tended to interfere with causeway cargo and tender boats alongside and were removed during lifting operations. They were replaced to rest the spreader bars on a hatch cover during rerigging procedures. The feet are attached by inserting the leg into a short pipe section on the underside of the spreader bar and pinning.

Cantilever Lift Frame (CLF)/Cargo Clearance

Connecting to Sections. Because of the requirement to load causeways with an offcenter longitudinal C.G., they float trimmed down at their forward (shipwise) end. In order to attach the forward slings (anti-rotation wires) the CLF must be lowered to a point where slack is generated in the after slings (spreaders). When lifted, the slack is pulled out and the clearance from causeway deck-to-CLF underside increases up to two feet, depending on the load and trim of the causeway.

The height of most items loaded on the causeways was not critical. However, the 140-ton (Figure 93), 60-ton, and 30-ton crane heights came within

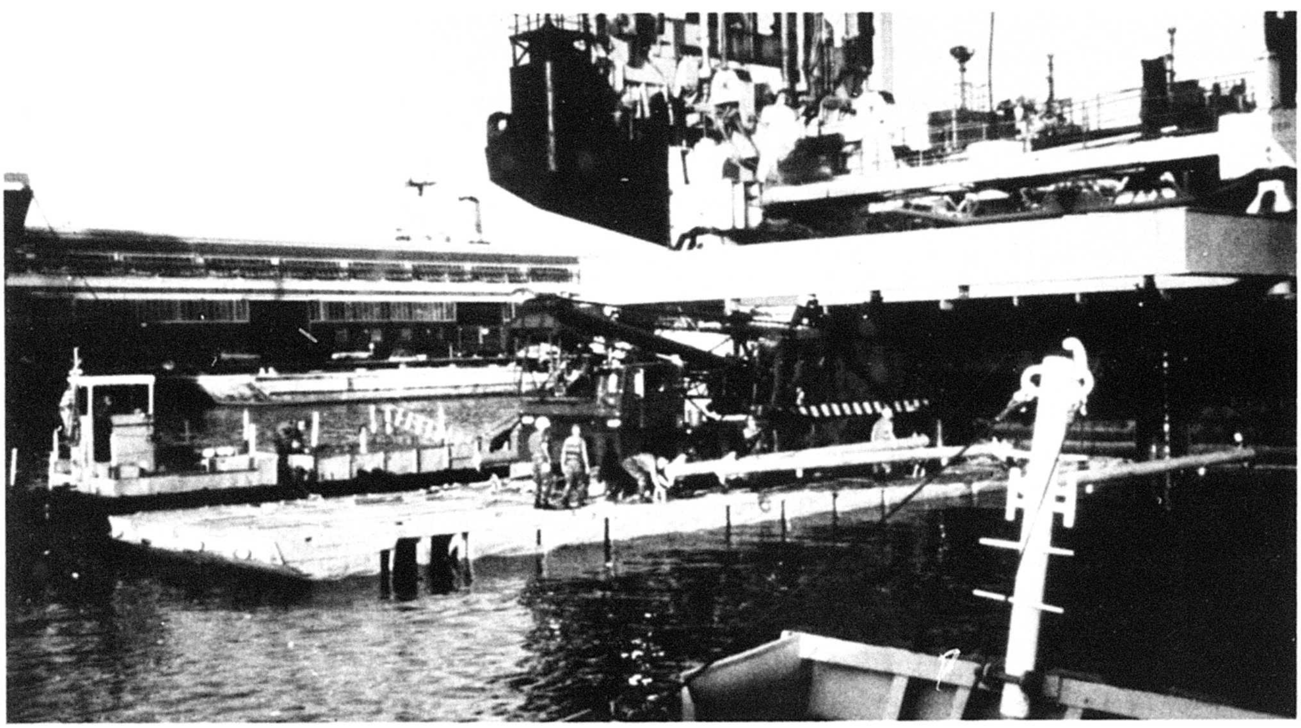


Figure 93 - Clearance While Connecting CLF Slings to Section with 140-Ton Crane

one to two feet of the CLF when the slings were being connected. The boom butt of the 140-ton crane actually exceeded the clearance, but projected aft beyond the range of interference with the CLF.

Loading and offloading took place in calm seas. If there had been vertical relative motion between causeway and CLF of one to two ft (this can occur at low sea states if the wave period causes resonant response in either or both causeway and ship) then the cranes would probably have struck the underside of the CLF.

Lifting the Sections. Once the sections were lifted they became parallel to the CLF at the maximum length of the slings. Not only did the clearances between the cargo and the CLF become fixed, but, because of the triangular suspension of the spreader slings, there was no longer any longitudinal relative motion possible between the section and the CLF. As the sections were lifted, the clearance between the causeway and the ship transom was 17 to 18 in.. When the sections were carried forward, using long slings, they had varying degrees of stern-down trim relative to the level of the hatch covers. Table 16 is a tabulation of the causeway trim and the weight of the causeway and its cargo. Figure 94 is a plot of the trims vs weights from Table 16 and shows a general increase in trim with an increase in weight. The aft trim apparently results from tolerances and flexibilities throughout the chain of components in the gantry crane reacting to the after C.G. presented by the causeway/CLF combination when the long slings are used.

When the long slings were replaced by the short slings on the fairly light turntable section and SLWT, a bow-down (relative to the plane of the hatch covers) trim of 8 in. and 6 in. respectively, resulted. The C.G. of the section is apparently shifted forward enough on the crane to produce a bow-down trim relative to the level of the hatch covers.

Moving and Stacking Sections. The clearance between the lifted section and the deck of the ship was affected by the trim of the section, as discussed above. When placing one section on another, the location on the ship, the height of dunnage required on the lower section, the height of cargo carried on an adjacent section, and the weight of the section being lifted became critical factors. When planning the loadout, consideration should be given to the following points for stacking causeway sections:

- The lower sections should not have bitts or other items which would require more than the minimum height of dunnage in order to conserve clearance for the upper sections.

Table 16 - TRIM OF CAUSEWAY SECTIONS
(with respect to the plane of the hatch covers)

Lift	Item[1]	Lift Weight (thousands of lbs)	Inches of Trim by Stern (lifted wt on slings)
1	Two Pierhead Sections	330	--
2	Piling	330	33
3	Bulldozer + Forklift	270	13
4	140-Ton Crane	256	14
5	Fenders	225.7	16
6	30-Ton Crane	215.9	11
7	Turntable	181	10[2]
8	60-Ton Crane	238.5	10
9	Tactical Causeway	138	9
10	Tactical Causeway	138	10
11	SLWT	208	38[3]
12	LACV-30[4]	---	--

1. Items 2-8 consist of a causeway section on which the listed equipment is mounted.

2. When the turntable section was lifted with the short slings, the trim was 8 in. by the bow.

3. The SLWT was lifted stern forward (shipwise). The anti-rotation wires were connected in the wrong place and pulled the stern end of the SLWT up. This contributed to the extreme amount of trim. When the SLWT was lifted with the short slings the trim was 6 in. by the bow.

4. The LACV-30 was lifted using a special set of self-adjusting slings.

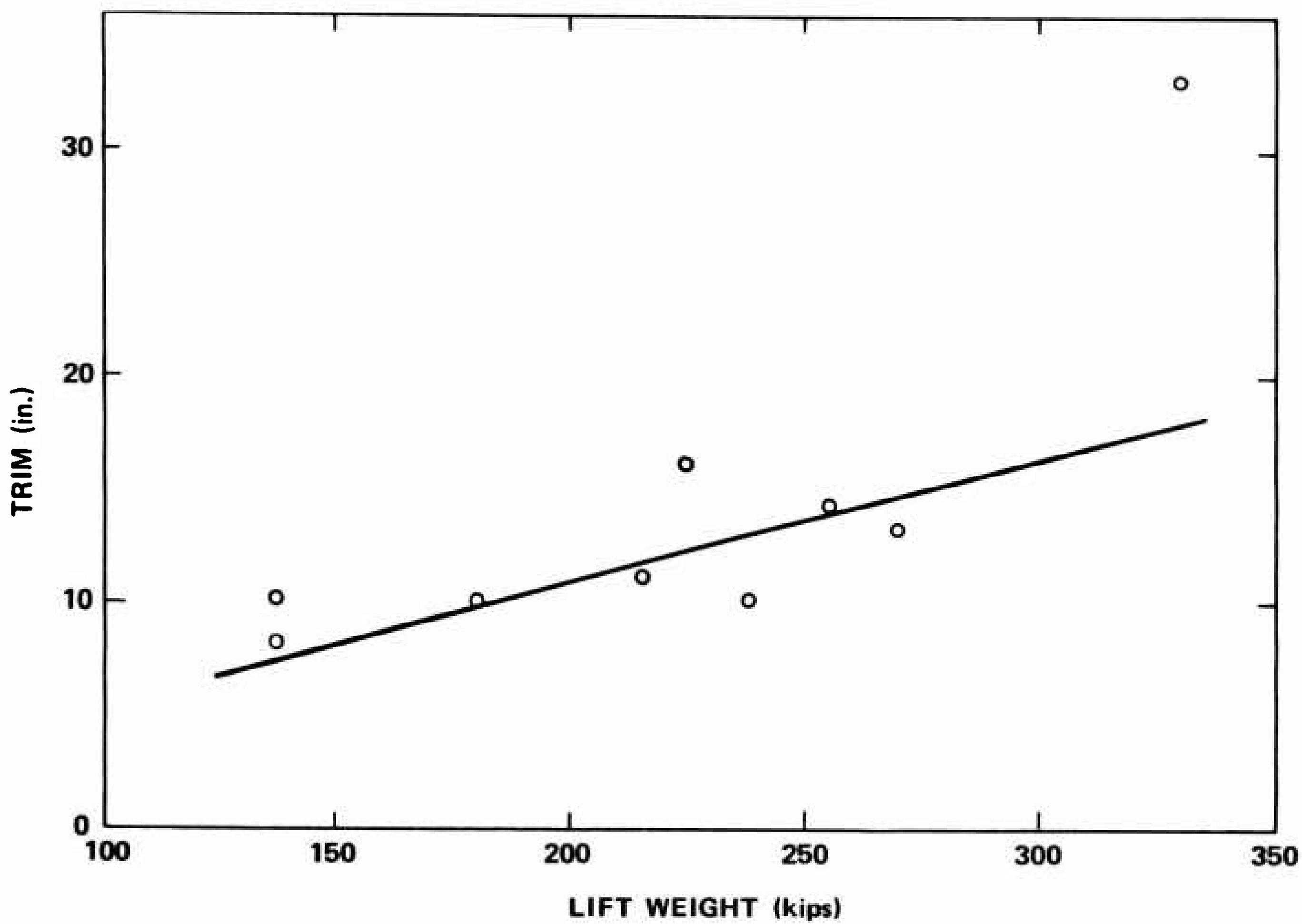


Figure 94 - Trim vs Lift Weight (Horizontal)

• The trim of the causeway (relative to the ship's deck) appears to increase with its weight as shown in Figure 94. This trim reduces available clearance when stacking.

• Careful planning is required when stacking adjacent (both) sides of a hatch cover. If the top section on one side is loaded with cargo, the CLF may hit that cargo when lowering an adjacent section into place. This is especially true when the CLF is using the short slings to place the adjacent section.

Problems can be avoided by placing sections on alternating sides rather than completing a stack on one side and then trying to place sections adjacent to the stack. Also, if the cargo on one side is lower than that on the other side, then the lower side should be placed first. This will allow more clearance for the CLF when placing the adjacent section. If necessary, the section can be adjusted forward/aft with respect to the lower section(s) in that stack so that the CLF beams will come down forward or aft of cargo on an adjacent section. This is what was done to place the section with the turntable (Lift 7) adjacent to the section with the bulldozer and forklift (Lift 3) as shown in Figure 77.

LACV-30 Slings The major difficulty with these slings was installing them on the CLF from the LACV-30. Like the CLF slings, they are heavy and stiff and required several people to shackle them to the CLF padeyes. They are self-leveling, and appropriate procedures must be followed to utilize this feature (discussed under procedures).

Dunnage Wood dunnage was used on the ship's hatch covers and on the decks of stacked causeway sections to distribute loads and to prevent possible damage to hull plating by projections such as cleats, bitts, container fittings, etc. Figure 95 shows dunnage distributed over the hatch covers.

Dunnage between stacked causeways was 4-in. x 4-in. x 16-ft stacked two-high to clear deck protrusions. The section with 18-in. mooring bitts required 24 in. of dunnage. This accommodates compression of the wood when the upper causeway was placed on top. Two layers of 12-in. x 12-in. timbers provide the necessary 24 in.. This dunnage should be placed over the assembly angles where the section strength is greater.

Storm Sea Lashings The three-high stack, with the SLWT on top, was to be lashed to the deck of the ship for storm sea conditions as a test event. However, the lashings purchased were not of the quick acting type desired for

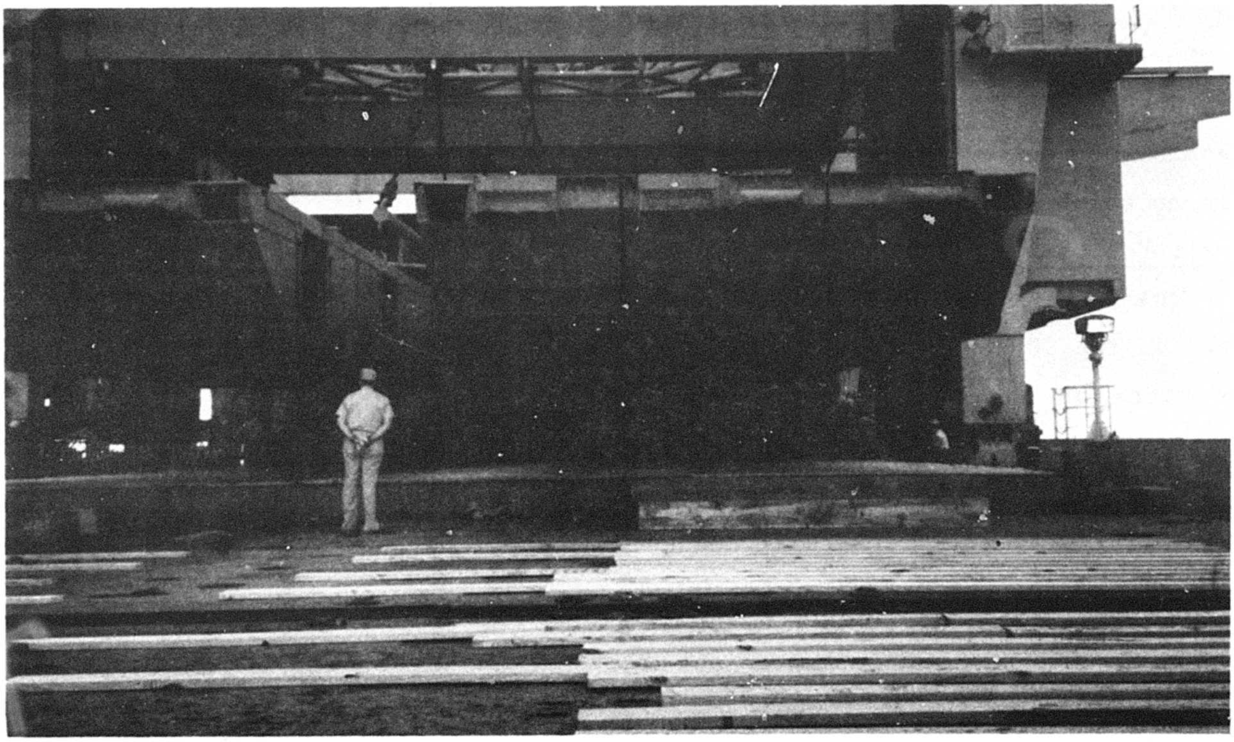


Figure 95 - Dunnage Pattern

the test and the location of the D-rings on the hatch covers was incorrect. Therefore, the lashing test was terminated before completion to conserve time. The use of standard Peck and Hale or equivalent lashings is recommended for installation by the ship's crew.

Military Communications - The military operators used walkie-talkies and radio packs to communicate between the ship and the Officer in Charge of the handling craft and causeway sections. The handling craft used their normal radios to communicate with each other. Performance of the radios in both of these cases was poor. When connecting the slings to a causeway section, the Chief in charge of the causeway crew used hand signals and shouting to communicate with the ship's personnel directing the gantry crane.

3.4.1.1.3 SHIP EQUIPMENT

Gantry Crane

The gantry crane interfaced and operated with the CLF with little difficulty. The only feature not anticipated was the deflection of the gantry system that allowed the causeway section being lifted to trim aft or forward, depending on the C.G. location, when using long or short slings. This trim reduced the deck-to-causeway clearance.

Shipboard Communications

The ship's deck crew communicated with each other and with the gantry crane operator by use of walkie-talkie and the cranes hard wired telephone. There were no shipboard communication problems.

Repair Equipment

The ship's engineering crew provided repair services for the damaged chain plate on the 30-ton crane section, and installed new D-rings in the correct locations on the SLWT. These repair services would best be provided by the military unit whose equipment is being shipped. A welding rig with oxyacetelene torch could be included in the loadout and a steel worker included in the causeway crew to make repairs if needed.

3.4.1.2 PROCEDURES

Causeway Section Loading

Placing the equipment on the causeway sections and installing the tiedowns was a long slow process which required several weeks to plan and perform. This was partly due to to the developmental stage of the loading manual and accompanying computer program. When these are finalized, a training program should be established to ensure that personnel are capable of planning, loading, and securing the equipment on the causeway sections in a reasonably short time. With practice, a planning and loading time of at least one week is expected.

A loading plan of the entire ELCAS system on a LASH ship(s) has not been developed. A generalized plan should be prepared to provide assistance/ guidance to personnel responsible for planning the loadout of an ELCAS for future operations. This plan should be developed using the experiences from JLOTS II and following the LASH Ship Loading Manual to ensure the safe loading of causeway sections. The plan should also establish the priorities of the ELCAS equipment and determine what, if any, equipment will be stored in the LASH barges inside the ship.

The Loading Manual for the LASH vessel[4] (includes computer program) must be carefully followed to ensure a safe loadout. The steps of this process are:

- Use the computer program to plan the loading of each section.
- Load the equipment on the sections but do not lash down.
- Measure the freeboards of each section as loaded.

• Using the freeboard numbers and the computer program, confirm that the loaded causeway sections are satisfactory to load/unload from the LASH ship.

• If a section is not satisfactory then the load must be either moved or reduced.

• Continue this process until all sections are suitable to load/unload and then lash the equipment into place. The computer program and loading manual provide minimum lashing requirements.

This procedure was basically followed, but, because of errors in the computer program, several loads had to be unlashed and moved to new locations.

The major changes in the loading included substituting a Super-20 Forklift for a D8 bulldozer (two D8's were too heavy) and removing a Drott 30-ton crane. The Drotts had to be loaded nose-to-nose at the end of the section which did not permit adequate lashing of the end crane. Also, the booms were each at the other's windshields so if either had shifted, two broken windshields would have resulted.

Causeway Handling and Movement

Personnel from the PHIBCB TWO used their standard causeway handling methods to bring the sections to the ship. The handling craft were either tender boats or warping tugs including the new SLWT. These craft secured alongside the sections to be lifted and propelled them into place at the stern of the ship.

The side of the section to which handling craft were attached was determined by the side of the ship on which that section was to be lifted. If the section was to go on the starboard side, then the propelling craft was attached to the starboard side of the causeway section and vice-versa. This was necessary because the spreader bars not used for the lift would come down on the craft if it were on the other side of the section (Figure 86).

The causeway had to be held in position at the ship's transom as the CLF was lowered for connection to the lifting attachment. When properly aligned, the causeway was about 2-ft aft of the ship's transom. Even under condition of gentle wind and current in the protection of the pier, tender boats had a difficult time maintaining the causeway's position within the small tolerance required to connect the spreader bar shackles to the causeway lifting rings. The anti-rotation slings were more easily connected because of their lighter weight. The warping tugs had an easier time maintaining position as long as the coxswain anticipated motion soon enough.

This procedure would be simplified by butting the causeway sections against a 2-ft camel secured to the stern of the ship (Figure 96). The craft handling the causeway section could simply hold it against the camel while the slings/spreader bars were connected to the section.

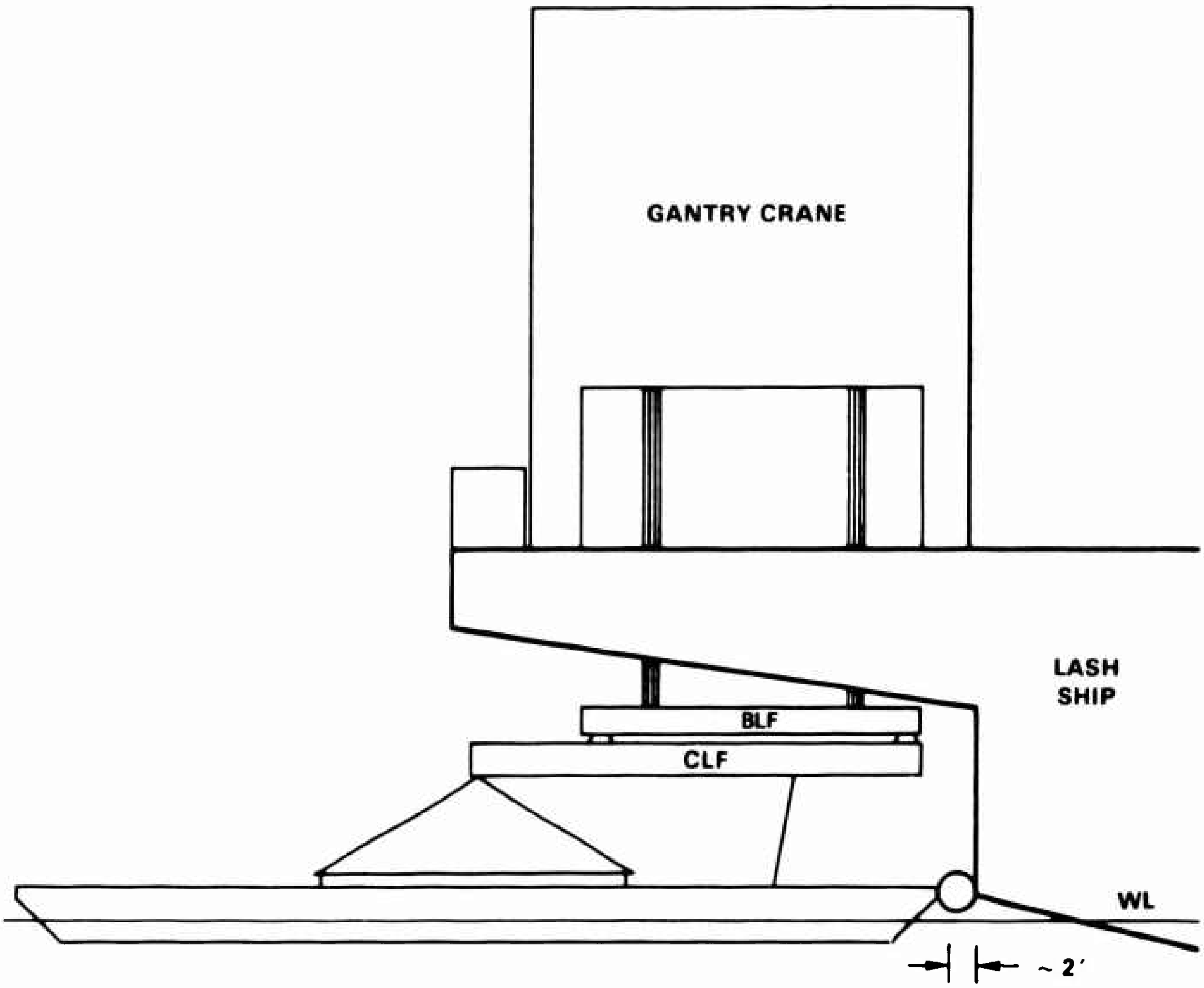


Figure 96 - Use of Camel to Position Causeway Section

Connecting CLF Slings to Causeway Section

The current design of the spreader bars makes this a calm water operation. The concept of pulling the spreader bar, with feet attached, inboa over the causeway's lifting rings then lowering them to the deck was not used in the test. While this would have resulted in a motionless interface between shackles and lifting rings, the spreaders were too heavy for the crew to handle, especially if the causeway position was not maintained. In addition, the feet of the spreaders interfered with some of the causeway deck loads, such as pilings and the turntable and with the handling craft. The feet were removed and the spreader was held in position just above the lifting rings while shackles were connected. Any relative motion between ship and causeway made this connection difficult and dangerous. The connection of the spreader bar to the lifting rings on the causeway is by 2-in. shackles which have threaded pins and nuts. The operation tends to be time consuming, awkward, and dangerous, especially when there is relative motion between ship and causeway. A quick connect/disconnect device and short pendants below the spreader bar would improve efficiency and safety.

Changing CLF Slings, Spreader Bars, and Anti-Rotation Wires

The rigging and rerigging of the CLF slings, spreader bars, and counter-rotational wires was the same whether for loading or offloading the ship. The standard (long) slings are used for lifting causeway sections from/to the water and for transporting them along the ship to their storage location. The short slings are used to stack sections whenever heights exceed the limits of the long slings.

The change of slings from long to short and back again occurred three times. The average time to change from long to short was 69 min and from short to long 60 min. As more experience was gained by the ship's crew, they developed the procedure of setting the spreader bar on the deck, disconnecting the long slings at mid-point leaving the lower section secured to the spreader bar. One upper (short) sling was then moved to the padeye on the forward transverse beam of the CLF. Rerigging to the long slings was just the opposite. This procedure greatly reduced the time required as shown by the last change: long to short, 23 min; and short to long, 38 min.

LACV-30 Positioning for Lift

A tender boat pushed the LACV-30 into place and held it with no problem during the attachment of the slings. The ship's barge handling lines could be used in future operations if the tender boat or warping tugs are not available. The LACV-30 could come in under its own power and tag lines from the ship's barge handling lines could be lowered to the crew who could secure the handling line to bitts on the craft. The ship could then use its barge positioning winches to hold or shift the LACV-30 as necessary during attachment to the CLF.

LACV-30 Sling Attachment

The LACV-30 was lifted using its special slings attached to the center two padeyes on the after transverse beam of the CLF. The first of the two slings was attached by the LACV-30 crew from the deck of their craft. The CLF, lowered to its limit, was about 9-ft above the LACV-30 deck. The sling was attached by throwing a line over the CLF beam and hauling it up to be shackled to the padeye. This proved very difficult and time consuming because of the weight and stiffness of the sling.

The second sling was lifted aboard ship and attached to the CLF padeye by ship's crew from a height of about 2-ft above the after hatch cover. This procedure was relatively easy and is recommended for future lifts of the LACV-30.

LACV-30 Sling Operation

On the initial lift, the LACV-30 came out of the water with a bow-down trim of about 7 ft (differential from bow to stern). It was held just above the water to allow the "keel" to drain with the expectation that this would cause the craft to level off. It did not level off and when lifted to the maximum height, it could not be brought aboard because of interference between the bow seal and the barge guide rail at the ship's transom. On the recommendation of the LACV-30 crew, the craft was lowered into the water and the slings adjusted automatically, as the craft rotated to zero trim. It became obvious that a "two step" lift is the correct procedure to be used to level the craft:

- The first lift is made to allow captured water to drain from keel compartments so that the C.G. of the "dry" craft hangs directly under the sling padeyes.
- Setting it back into the water rotates the craft to zero trim and forces an adjustment in the slings.

The craft must be picked up again before it drifts from this position and causes the slings to adjust away from the zero trim condition.

3.4.1.3 PERSONNEL

A basic difference to be noted between the LASH and SEABEE tests was that the crews in the support craft, handling the sections, and working the slings remained the same throughout the LASH Deployment test. In contrast, the crew of each test article in the SEABEE deployment assisted in the loading and back-loading operations, i.e., they performed "one time" events. Thus, the personnel in the LASH test gained much more experience and performed tasks more quickly by the end of the test.

Table 17 shows the number and sources (Navy, Ship, NSC, or Army) of the personnel used in the various activities of the loadout and offload of the LASH ship. Footnotes are added for clarification.

3.4.1.4 TIMES

Table 18 presents a breakdown of elapsed times for each of the loadout activities listed on the ordinate. The times in each vertical column are cumulative and the total time includes all delays which occurred during a particular lift, e.g., stopping for inspection, making decisions on unexpected problems, etc. Footnotes are added for clarification.

These times reflect the results of the crews gaining experience during the loadout. This was possible since the crews and the tasks remained basically the same during the entire loadout. The only exception to this was the LACV-30 which was handled by its own crew.

3.4.1.5 ENVIRONMENTAL IMPACTS (LASH LOADING)

Some difficulty was experienced in maintaining position of the causeway sections in the crane well while connecting the slings. The drifting was attributed to wind, inexperience of the coxswains, and marginal maneuverability of the tender boats.

3.4.2 LASH SHIP OFFLOADING

The equipment, procedures, personnel, time, and environmental conditions during LASH offloading are discussed in this section.

3.4.2.1 EQUIPMENT

The test articles, support equipment, and ships equipment used in the offload were the same as those discussed above for loading the ship. New D-rings were installed in the proper position.

TABLE 17 - PERSONNEL

Activity	Personnel	
	Loadout	Offload
Handling Causeway Sections[1]	- Navy Boat Crews and 1 BMC -	
Attach/Detach Slings (floating)[2]	5-7 Navy w/EOCS	3-7 Navy w/EOCS
Attach/Detach Slings (shipboard)[3]	4-8 Ship w/Ch.Mate	3-6 Ship w/Ch.Mate
Gantry Crane Operations	- 1 Operator and 2-3 Guides, Ship -	
CLF Sling Rerigging[4]	16 Ship & NSC w/Mate	6 Ship w/Ch. Mate
Lashing	18 (9 ship, 9 NSC)	
Unlashing[5]		23 (5 ship, 18 Army)

1. Handling causeway sections includes bringing sections to/from the ship and causeway ferry assembly. When sections were end-connected at the ship, the causeway crew assisted. The crews of the handling craft (LCM-6s, warping tugs and SLWT) were adequate in number. A boatswains mate chief BMC) was in charge of overall boat operations.

2. Attaching/detaching the slings from the floating causeway sections was done by a military causeway crew under control of an Equipment Operator Senior Chief (EOCS). This crew also unlashed the vehicles during the offload and moved them so the end connections could be performed to make up causeway ferries.

3. Performed by ships personnel except that the LACV-30 slings were attached by the LACV-30 crew during loading and offload.

4. The technique andquipment used to rerig the CLF from long to short and back to long slings evolved from experience during the onload so that six ship's personnel and the Chief Mate could do it during the offload vs sixteen personnel during the loadout.

5. The Army personnel assisted until all lashings were loose from the deck (15 min). Ship's personnel removed the lashings from the sections and stacked them.

TABLE 18 - LOADING TIME BY EVENTS
(HOURS:MINUTES)

EVENT / LIFT	1 Two Causeways	2 Piling	3 Bulldozer	4 140T Cr	5 Fender	6 30T Cr	7 Turntable	8 60T Cr	9 Causeway	10 Causeway	11 SLWT	12 LACV-30
APPROACHES SHIP & POSITIONS IN WELL	0:05	0:01	0:03	0:01	0:02	0:03	0:02	0:03	0:05	0:04	0:02	0:08
GANTRY LOWERS CLF	0:05	0:01	0:04	0:03	0:02	0:02	0:07	0:04	0:04	0:03	0:02	0:32[10]
SLINGS ATTACHED	0:07	0:02	0:02	0:02	0:02	0:02	0:02	0:02	0:01	0:02	0:14	0:54[11]
GANTRY LIFTS LOAD	0:09	0:05[2]	0:05	0:06	0:06	0:04	0:38[4]	0:04	0:04	0:04	0:05	0:11
GANTRY MOVES FORWARD	0:07	0:05	0:05	0:04	0:14[3]	0:03	2:26[5]	0:03	0:02	0:06	1:27[7]	0:50[12]
GANTRY LOWERS LOAD ON DECK	0:02	0:06	0:01	0:02	-	0:01	0:01	0:02	0:07	0:04	0:05	0:12
SLINGS REMOVED	0:15	0:11	0:03	0:02	0:05	0:04	0:02	0:02	0:02	0:03	0:09[8]	0:05
GANTRY LIFTS CLF	0:01	0:02	0:03	0:01	0:01	0:01	0:01	0:01	0:01	0:01	0:02	0:01
GANTRY/CLF MOVES AFT	0:07[1]	0:02	0:04	0:04	0:04	0:03	0:50[6]	0:06	0:04	0:03	0:19[9]	-
TOTAL	0:58	0:35	0:30	0:25	0:36	0:23	04:09	0:27	0:30	0:30	2:25	2:53

TABLE 18 (FOOTNOTES)

1. Does not include 43 min to rerig for centerline lift for ABS Test.

2. Does not include the 5-min which the load is held for the ABS test.

3. Includes 11 min to ponder where final deck stowage position should be. Also, includes an 8 min mechanical problem with the gantry crane (indicator light out).

4. Includes a 34-min delay while bolts are removed from the turntable beam which interferes with the spreader bar foot attachment pipe.

5. Includes 27 min to discuss and then reposition the load for rerigging. Also, includes 1 hr 51 min for rerigging to short slings.

6. Includes 42 min for rerigging to long slings.

7. Includes 1 hr 12 min to set the SLWT on the deck and rerig to short slings.

8. Includes 7 min to remove the starboard center sling to clear the way for the LACV-30.

9. Includes 13 min to remove the port center sling to clear the way for the LACV-30.

10. Includes 30 min for discussion and positioning the LACV-30 to begin to attach slings to the CLF from deck of the LACV-30.

11. Includes 27 min to bring the CLF up and attach the second LACV-30 sling to the CLF from the deck of the ship.

12. Includes 43 min for discussion and finally for lowering the LACV-30 back to the water to let the slings center themselves.

3.4.2.2 PROCEDURES

The offload procedures were basically a reverse of the loading procedures. The gantry crane lifted the sections from their storage locations, carried them aft to the well, and lowered them to the water. The causeway crew disconnected the CLF slings, and the sections were pulled away from the ship. The unique features of the offload are discussed below.

LACV-30 Offload

The LACV-30 was lowered to the water and held by the slacked slings while the engines were started. The craft twisted and drifted sideways and came close to contacting a lowered spreader bar. This could be avoided by keeping tension on the slings or by using the ship's barge handling lines to hold the craft in the current or simply to use a tender boat or warping tug to pull the craft free of the ship before starting engines. The latter procedure would free the gantry to proceed with the offload.

Changing CLF Slings

The process of changing the CLF slings was basically the same as discussed for the loading. The crew became more familiar with the sling system and performed the change quicker every time it was done. It was still a very difficult task and could be eased greatly by including a short sling permanently on the forward padeyes, and by adding a third hole in the aft padeye and permanently installing a short pendant there. The short pendants could be attached to causeway loads by swinging the spreader bars outboard of the causeway section and lowering the CLF to the necessary height.

Disconnecting CLF Slings

After the sections were lowered to the water and the handling craft had been attached, the slings/spreader bars were disconnected. The feet were left off of the spreader bars for the entire offload except when reinstalled to support the spreader bars on a hatch cover while the slings were being changed. The causeway crew became familiar with the procedure and could disconnect the slings from the section in almost the same time it took the boat crew to attach the handling craft to the section.

Problems arose when the section experienced motion during the disconnection however. As discussed earlier, the process of connecting/disconnecting the shackles under the spreader bar becomes hazardous when the causeway is moving. The presence of wind or current tends to make the causeway drift sideways, which makes the spreader bar move into or away from the section and the personnel trying to disconnect the shackles. In several cases, this caused damage to or loss of shackle pins.

Connection/disconnection of the spreader bars to the lifting rings could be made simpler and safer by adding short pendants to the ends of the spreader bars to increase the vertical clearance. This would allow greater margin in the positioning of the causeway while the shackle connection was being made. It is unlikely the existing causeway-to-CLF clearance could be maintained by shortening the slings above the spreader. Any change in the sling geometry would require a structural reevaluation/redesign of the system. However, the use of pendants below the spreader bar would reduce the personnel hazard, and the pendants could be removed when necessary, once the load was on the deck of the ship.

Other options for improvements of this system include:

- Provide a fender/camel at the transom of the ship for the section to be held against. This would line the causeway lift rings up with the CLF spreader bars and would allow the tending craft to hold the section tight against the ship's transom during the disconnect operations.
- Redesign the causeway lift rings so they can take an appropriate side load, thus eliminating the need for heavy spreader bars.
- Use safety hooks or similar quick connect/disconnect device with a swivel instead of the current shackles to shorten the time required to connect/disconnect.

Causeway Handling

Three techniques were used to remove the causeway sections from the ship's well. These are:

- End connect a warping tug (or previously end-connected section) to offloaded sections while still connected to the CLF slings. Then disconnect the slings, pull back from the ship and end-connect to the next section, etc. This method provided for the assembly of the causeway ferries with only one handling craft since the ship was holding each successive section. However, the procedure was not always a quick one and the offload was delayed until the connection was completed and the CLF slings released.
- Secure (not end-connect) a handling craft to the section being offloaded, pull it from the ship and connect that section to previously offloaded sections away from of the ship to form a causeway ferry. While this was

being done, another handling craft went to the ship to get the next section being unloaded. The problem with this method is that it required three handling craft and the causeway handling crew had to be transferred to the next craft going to the ship.

- Secure a tender boat to the section, pull it from the ship and transfer it to another craft for assembly into a causeway ferry while the tender boat immediately returns to the ship with the causeway crew to get the next section being unloaded. This third method was followed consistently towards the end of the offload and worked well for clearing sections from the ship and keeping the causeway crew available to disconnect the CLF slings.

- The connection of the sections into causeway ferries was accomplished with difficulty in some cases since the sections floated with differing amounts of trim. The freeboards on some of the sections were adjusted by unlashing the vehicle cargo and moving it until the freeboard matched the section to which it was to be connected. This could be a hazardous procedure if sea conditions caused significant causeway motion.

3.4.2.3 PERSONNEL (See Section 3.4.1.3)

3.4.2.4 TIMES

Table 19 presents a breakdown of elapsed times for each of the offload operations. All events were similar to the onload, except reversed.

3.4.2.5 ENVIRONMENTAL IMPACT

Seas were relatively calm with waves varying from 1/2 to 1 ft. Refer to Section 3.3.5 for details. Currents up to 1-1/4 knots and winds up to 20 knots caused some difficulty in maintaining causeway position while disconnecting the slings. The accumulating experience of the coxswain throughout the day resulted in improved performance in controlling the sections.

3.4.3 LASH SHIP BACKLOADING

The backloading exercise was completed with some difficulty due to the amount of motion of the section resulting from a 20-knot wind and the problems of the handling craft to hold it in place long enough to get the shackles connected/disconnected.

TABLE 19 - OFFLOADING TIME BY EVENTS
(HOURS:MINUTES)

EVENT / LIFTS	1 LACV-30	2 SLWT	3 Causeway	4 Causeway	5 60T Cr	6 30T Cr	7 Fenders	8 140TCr	9 Piling	10 Bulldoz.	11 Turn-table	12 Cause-ways
GANTRY LOWERS CLF	0:01	0:01	0:01	0:01	0:01	0:01	0:01	-	0:01	-	0:01	-
SLINGS ATTACHED	0:22[1]	0:26	0:02	0:02	0:03	0:01	0:01	0:03	0:01	0:02	0:01	0:05
GANTRY LIFTS LOAD	0:02	0:01	0:01	0:01	0:01	0:01	0:02	0:01	0:01	0:01	0:01	0:02
GANTRY MOVES AFT	0:06	2:05[2]	0:04	0:03	0:04	0:03	0:04[6]	0:04	0:04	0:06	0:40[9]	0:19[10]
GANTRY LOWERS LOAD INTO WELL	0:05	0:04	0:02	0:04	0:04	0:03	0:03	0:04	0:03	0:04	0:03	0:03
SLINGS REMOVED	0:15	0:02	0:09	0:08	0:08[3]	0:16[5]	0:04	0:02	0:02	0:02	0:02	0:02
GANTRY LIFTS CLF	0:03	0:03	0:03	0:04	0:03	0:03	0:04	0:04	0:03	0:03	0:03	0:11
GANTRY MOVES FORWARD	0:01	0:03	-	0:03	0:14[4]	0:03	0:10[7]	0:03	0:04	0:32[8]	0:04	-
TOTAL	0:55	2:45	0:22	0:26	0:38	0:31	0:29	0:21	0:19	0:50	0:55	0:42

TABLE 19 (FOOTNOTES)

1. Crew was not completely assembled. Attaching slings was done by those crew members on hand while waiting. 20-min delay.

2. Lowered SLWT to deck. 1-hr 38 min for changing to long slings. Simultaneously welding on new D-rings for connection of anti-rotation wire. Delayed 17 min after slings were ready to complete welding.

3. Spreader bar feet interfere while attempting to tie LCM-6 alongside section (4-min delay).

4. Stopped over aft hatch cover and attached center port spreader bar not used since onload (10-min delay).

5. 9-min delay while waiting for LCM-6 with previous load (60-ton crane) to reach ship for end connecting to this load.

6. Stopped offload due to gantry electrical problem (10-min delay not included.

7. 5-min delay included while the gantry stopped and lowered to remove those spreader bar feet that were not removed by causeway crew during backload evolution.

8. 23-min included for switching to short slings.

9. 38-min included for switching to long slings.

10. 12-min included for stopping over last hatch cover to remove dunnage from starboard section.

3.4.3.1 EQUIPMENT

The backload exercise was performed with the section carrying the ELCAS fender units. These units are the same length as the causeway and so personnel had to squeeze around the ends of the fenders to get from one side of the section to the other. The fender units have a lot of sail area which caused the section to drift.

3.4.3.2 PROCEDURES

The initial difficulties resulted from the position of the tender boat which attached to the port side of the causeway since the section was offloaded from the ship's port side just prior to the backload. The backload was performed on the ship's starboard side which put the tender boat under the middle set of spreader bars. This was an unworkable and dangerous situation with the boat crew struggling with the spreader bars and trying to prevent them from damaging the tender boat. The tender boat was disconnected and replaced by a warping tug on the starboard side of the section.

Connection of the spreader bars to the lifting rings was difficult due to motion of the section and required 9 min to complete versus a typical 2 min while in the harbor. Control of the causeway to be backloaded could be made easier by pushing the section against the ship and shifting the gantry crane to align the spreader bars with the PH-10 lifting rings or by including a camel against the ship's transom to put the section at a proper stand-off when nosed against it. In addition, radio communications between the causeway crew leader, the operator of handling craft, and the ship's crew would be useful.

3.4.3.3 PERSONNEL (See Section 3.4.1.3)

3.4.3.4 TIMES

Table 20 presents a breakdown of the elapsed times for the backload operation. The procedure was the same as for onloading but with slightly increased motion of the section.

3.4.3.5 ENVIRONMENTAL IMPACTS

The wind present caused some motion of the section due to the sail area of the fenders. This motion caused difficulties in attaching the slings as discussed above.

TABLE 20 - BACKLOADING TIME BY EVENTS (Section)
(HOURS:MINUTES)

EVENT	TIME
APPROACHES SHIP AND POSITIONS IN WELL	0:10
GANTRY LOWERS CLF	0:06
SLINGS ATTACHED	0:09
GANTRY LIFTS LOAD	0:02
GANTRY LOWERS LOAD	0:02
UNHOOKS	0:03
GANTRY LIFTS CLF	0:04
TOTAL	0:36

3.5 CONCLUSIONS AND RECOMMENDATIONS

The overall mission of the test was to load the selected test articles aboard a LASH ship at a pier utilizing the ship's loading equipment, stow them on deck, and offload them in the stream. The mission was carried out by a combination of military, ship's and Naval Supply Center (NSC) personnel with only one injury (a minor cut hand), bent chain plates on several causeway sections, and bent assembly angles on the SLWT. This damage did not affect the operational capability of any of the test articles.

The ship's equipment in conjunction with the new cantilever lift frame CLF proved capable of handling the test articles. The changing of the CLF slings in order to stack causeway sections was a difficult and potentially dangerous task.

However, the ship's crew developed the techniques necessary to accomplish this relatively quickly with a minimum of risk to personnel.

The total operation was conducted in moderate weather with only minor difficulties in causeway section handling due to a cross wind during the offload. The connection/disconnection of the CLF slings to floating causeway sections proved to be a calm water operation because of the size and motion of the spreader bar.

One military crew was used for all connecting/disconnecting of the CLF slings to/from floating sections. This worked very well since they gained experience and learned to perform the tasks quickly. The same 'one crew' concept worked on the ship where ship's crew connected/disconnected and rerigged the slings. Training and prebriefing of the techniques developed would be valuable for new crews.

3.5.1 PLANNING FACTORS

Planning factors for the deployment of causeway sections, SLWT's and LACV-30's are developed for ship loading and discharge TIMES, MANPOWER requirements, and SUPPORT EQUIPMENT required. Ship loading and discharge operations are basically the same for causeways sections and SLWT's so these are combined.

3.5.1.1 TIME

The time to load and offload ALS/LOTS equipment on a LASH ship can be discussed in terms of the time to complete one cycle of the gantry crane. Table 21 gives general time planning factors for loading and offloading equipment on a LASH ship. Extra time is needed to stack causeway sections three high since the slings have to be changed from long to short and back to long. This time is also listed.

The time required to plan and load the causeway sections is not included since an operational loadout was not performed. Detailed loadout plans for the entire ELCAS system and other candidate loads for the LASH ship are needed. This would give planners a base to work from and could be modified as necessary during an actual loadout. All causeway section loads and weights must be verified prior to being loaded on the LASH ship. The use of LASH barges to carry ELCAS materials should be investigated and barge unloading techniques developed and tested.

TABLE 21 - TIME PLANNING FACTORS FOR LASH SHIP LOADING/OFFLOADING

Equipment Type	Causeway Section, SLWT	Two Empty Causeway Sections	LACV-30
Loading/Off-loading Time (per gantry crane cycle)	30 min	45 min	1 hr*
* Includes time to change to LACV-30 slings.			
Stacking Each change of the slings, long-to-short or short-to-long, will require 30 min to 1 hr depending on the experience of the crew			

3.5.1.2 MANPOWER

The manpower required for deploying ALS/LOTS equipment on LASH ships consists of both ship's crew and military crews of equipment items. Table 22 includes the major tasks performed, the source (military or ship), and the recommended number of personnel actually performing/supervising the tasks.

TABLE 22 - MANPOWER PLANNING FACTORS FOR LASH SHIP OPERATIONS

Activity	Workers/Supervisors	
	Source	Numbers
Handling Causeway Sections	Military	Normal Crew
Attach/Detach Slings (floating)	Military	8/1
Attach/Detach Slings (shipboard)	Ship	6/1
Gantry Crane Operations	Ship	3/1
CLF Sling Rerigging	Ship	6/1
Lashing Aboard Ship	Ship/Military	16/4

3.5.1.3 SUPPORT EQUIPMENT

The major items of support equipment are the CLF, handling craft, dunnage, and lashings as listed in Table 23. The CLF is attached to the ship's gantry crane and therefore acts as part of the ship.

TABLE 23 - SUPPORT EQUIPMENT PLANNING FACTORS FOR LASH SHIP OPERATIONS

Item	Quantity or Logic for Determining Quantity
CLF	One
Handling Craft	During the loadout, 2 craft could perform the task if the remainder of the sections are moored at a pier. During the offload the number of handling craft required depends on the number of causeway ferries to be made-up. They can be SLWT's which are included in the load. Five handling craft (2-LCM-6's, 2-warping tugs, 1-SLWT) were utilized for the 11 nonpowered sections included on the ship.
Dunnage	Quantity and size depends on the items to be loaded and the expected sea conditions during transport. The condition of the hatch covers of the ship to be loaded could also affect the dunnage requirements. For these reasons it is recommended that the ship be provided with the cargo characteristics and tasked to provide a list of dunnage needed according to their specific ship's conditions
Lashings	Equipment-to-causeway lashing should be done by the owning unit prior to being loaded on the ship. The quantities should be calculated using the LASH Loadout Manual. Causeway-to-ship lashings should be provided by the ship for the same reasons as stated above for dunnage.

3.5.2 EQUIPMENT

Recommendations pertaining to causeway sections, CLF, and LASH ships are listed below.

Causeway Sections

- Cargo must be carefully planned, loaded, and checked according to the LASH Loadout Manual and accompanying computer program. The cargo lashing and blocking should also be reviewed for adequacy. Lashing materials should be standard lashing items such as Peck and Hale.

- Causeway sections with bitts should be selected for carrying light cargo and/or for loading on top of a stack if possible. If not, then ample dunnage must be provided with the section or on the ship to provide clearance for the bitts and to properly distribute the load.

- The cargo aboard the causeway sections should include a welding unit and oxyacetalene torch that can be used for emergency repairs during loadout.

- Cargo height and width must be checked to prevent interference with the CLF and spreader bars as they are raised and lowered.

- To prevent damage to the causeway section the D-rings for attaching the anti-rotation wires to causeways must be installed on top of the assembly angles between pontoons (this is where assembly bolts are closest together). If there is a chain plate at this location, it should be welded all around, especially along the outside edge. The D-rings on the SLWT must be installed on top of the assembly angles between the closest spacing of the assembly bolts.

Cantilever Lift Frame

There are many opportunities for modifying the CLF to improve its performance, to reduce the effort required to attach the slings to the causeway sections, and to rerig the slings for stacking sections. The possible modifications listed below provide alternatives which should be investigated thoroughly before redesigning the CLF and associated slings.

- The CLF should include a set of short pendants which remain on the forward and aft padeyes (modify the aft padeyes to include three holes to support both the long and short slings simultaneously) to eliminate the rerigging process, or

- The slings and CLF padeyes should be color coded to clarify the rigging configurations.

- The causeway lifting rings could be redesigned to allow them to take a sideways load. This would eliminate the need for the spreader bars altogether and would make the sling system a set of long pendants which would be lighter and safer and which would allow greater tolerance in craft position and motion during connection/disconnection operations.

- Pendants could be added below the spreader bar thus raising the bar above the heads of the crewmen connecting/disconnecting it or

- The spreader bar foot could be redesigned and the CLF padeyes moved (transversely) closer together so the spreader bar could be set on the causeway deck while the shackles are being connected/disconnected. The current foot design interferes with cargo on the sections and with tender boats/warping tugs tied alongside.

- The shackles that attach to the causeway section should be changed to safety hooks or quick attach/release hooks to reduce the time the crew members are exposed to the swinging spreader bars.

- Spare shackles should be included with the CLF.

<u>Lash Ship</u>

- Dunnage requirements and layout should be calculated by the ship's personnel based on the proposed loads and the hatch cover strength of that particular ship.

- The ship's repair facilities (welding equipment and cutting torch) and personnel should be available to perform any necessary repairs.

- A fender or camel should be placed at the stern of the ship so the sections can be held against it to prevent drifting. This fender/camel should be sized so that the causeway standoff from the ship's transom provides alignment of spreader bars with the causeway lifting rings.

3.5.3 PROCEDURES

The following recommendations pertain to procedures for deploying equipment aboard a LASH ship.

- A warping tug or SLWT should be used to handle the causeway sections in the ship's well. A single tender boat has insufficient power/maneuverability to maintain causeway alignment under crosswind or crosscurrent conditions.

- The handling craft should always be to the outside of the ship or end connected to the section in the crane well so it is not under the offside spreader bars.

- One handling craft with the causeway crew should be used to bring and connect all the sections to/from the ship. Thus, one crew will develop experience.

- The handling craft should be standing close by, but clear of the section before it is lifted from or set into the water.

- Personnel operating the handling craft and directing the causeway crew and gantry crane should have radio sets that allow them to communicate when out of line of sight. The causeway crew chief should have a voice actuated radio headset.

- The attachment/detachment of the shackles under the spreader bars should be done by a team of four men per spreader bar (two per end, one to hold the spreader bar and shackle and the other to handle the nut and pin).

- If the causeway section or SLWT has a large trim, then the shackles at the high end of the spreader bar should be connected first.

- Stacking of causeway sections should be carefully planned and sequenced when adjacent to sections with cargo since the cargo could interfere with lowering the CLF.

- Lashing of causeway sections to the ship should be planned and accomplished by ship personnel and should use standard lashing materials. The lashing plan should be reviewed by the causeway section owning units.

- Rerigging from long to short slings should be done on hatch covers where there is no adjacent causeway section to interfere with lowering the CLF.

- The LACV-30 slings should be attached to the CLF from the deck of the ship rather than from the deck of the LACV-30.

- The procedure for proper operation of the LACV-30 slings should be followed.

- During the offload, tension should be kept on the CLF slings to hold the causeway section or LACV-30 in place until the crew arrives to disconnect slings or the engine start-up procedure is complete; or

- The ship's barge handling lines could be used to hold the section or LACV-30 in place. This would free the gantry crane to proceed with the initial steps of the following offload.

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FPO San Francisco, CA 96601-5806

Commander
Amphibious Squadron 8
FPO New York, NY 09501-5807

Commander
Amphibious Squadron 10
Naval Amphibious Base
Little Creek, VA 23521

Commander
Amphibious Squadron 12
Naval Station
Norfolk, VA 23511

Commander
Military Sealift Command, Atlantic
Military Ocean Terminal, Bldg. 42
Bayonne, NJ 07002

Commander
Naval Beach Group ONE
Naval Amphibious Base, Coronado
San Diego, CA 92155

Commander
Naval Beach Group TWO
Naval Amphibious Base, Little Creek
Norfolk, VA 23521

Commanding Officer
Amphibious Construction Battalion 1
Naval Amphibious Base, Coronado
San Diego, CA 92155

Commanding Officer
Amphibious Construction Battalion 2
Naval Amphibious Base, Little Creek
Norfolk, VA 23521

Commanding Officer
Assault Craft Unit 1
Naval Amphibious Base, Coronado
San Diego, CA 92155

Commanding Officer
Assault Craft Unit 2
Naval Amphibious Base, Little Creek
Norfolk, VA 23521

Commanding Officer
Beach Master Unit 1
Naval Amphibious Base, Coronado
San Diego, CA 92155

Commanding Officer
Beach Master Unit 2
Naval Amphibious Base, Little Creek
Norfolk, VA 23521

Commander
Navy Cargo Handling and Port Group
Williamsburg, VA 23185

Military Sealift Command Office,
Norfolk
Bldg. Y100A, Naval Supply Center
Norfolk, VA 23512-5000

Commanding Officer
Naval Civil Engineering Laboratory
Port Hueneme, CA 93043

Commanding Officer
Naval Coastal Systems Center
Panama City, FL 32407

Commanding Officer
Naval Amphibious School, Little Creek
Norfolk, VA 23521

Commanding Officer
Naval Amphibious School, Coronado
San Diego, CA 92155

Commandant of the Marine Corps
Headquarters, U.S. Marine Corps
Washington, DC 20380
(Code: LME-1, LPJ, LPP, LMM, LPS)

Commanding General
Fleet Marine Force, Atlantic
Attn: G4
Norfolk, VA 23515

Commanding General
Fleet Marine Force, Pacific
Attn: G4
Camp H.M. Smith HI 96861

Commanding General
I Marine Amphibious Force
Attn: G4
Camp Pendleton, CA 92055

Commanding General
II Marine Amphibious Force
Attn: G4
Camp Lejeune, NC 28542

Commanding General
III Marine Amphibious Force
Attn: G4
FPO San Francisco, CA 96606

Commanding General
1st Marine Division
Attn: G4
Camp Pendleton, CA 92055

Commanding General
2nd Marine Division
Attn: G4
Camp Lejeune, NC 28542

Commanding General
3rd Marine Division
Attn: G4
FPO San Francisco, CA 96603

Commanding General
4th Marine Division
Attn: G4
New Orleans, LA 70146

Commanding General
1st Marine Aircraft Wing
Attn: G4
FPO San Francisco, CA 96603

Commanding General
2nd Marine Aircraft Wing
Attn: G4
Marine Corps Air Station
Cherry Point, NC 28533

Commanding General
3rd Marine Aircraft Wing
Attn: G4
Marine Corps Air Station, El Toro
Santa Anna, CA 92709

Commanding General
2nd Force Service Support Group (REIN)
Attn: CSS
Camp Lejeune, NC 28542

Commanding General
3rd Force Service Support Group (-)
Attn: CSS
FPO San Francisco, CA 96604

Commanding General
1st Force Service Support Group (-)
Attn: CSS
Camp Pendleton, CA 92055

Commanding General
1st Marine Amphibious Brigade
Attn: G4
Kanehoe Bay, HI 96861

Commanding General
4th Marine Amphibious Brigade
Attn: G4
Naval Amphibious Base, Little Creek
Norfolk, VA 23521

Commanding General
6th Marine Amphibious Brigade
Attn: G4
Camp Lejeune, NC 28542

Commanding General
7th Marine Amphibious Brigade
Attn: G4
29 Palms, CA 92278

Commanding General
9th Marine Amphibious Brigade
Attn: G4
FPO San Francisco, CA 96603

Commanding General
Marine Corps Development and Education Command
Attn: M&L Division
Quantico, VA 22134

Commanding General
Landing Force Training Command Atlantic
(Attn: Logistics/Embarkation)
Naval Amphibious Base, Little Creek
Norfolk, VA 25321

Commanding General
Landing Force Training Command Pacific
(Attn: Embarkation)
U.S. Naval Amphibious Base, Coronado
San Diego, CA 92155

Advance Amphibious Study Group
Headquarters, United States Marine Corps
Attn: COL Conatsur
Quantico, VA 22134

Director
Marine Corps Operational Test and Evaluation Activity
Quantico, VA 22134

Commanding Officer
2nd Landing Support Battalion
2nd Force Service Support Group (Rein)
Camp Lejeune, NC 28542

Commanding Officer
1st Landing Support Battalion
1st Force Service Support Group (-)
Camp Pendleton, CA 92055

Commanding Officer
3rd Landing Support Battalion
3rd Force Service Support Group (-)
FPO San Francisco, CA 96604

Headquarters
U.S. Air Force (LET)
Washington, DC 20330

Headquarters
U.S. Air Force (XOORE)
Washington, DC 20330

Headquarters
Military Airlift Command (TR)
Scott Air Force Base, IL 62225

Headquarters
Tactical Air Command (LGT)
Langley Air Force Base, VA 23665

Headquarters
U.S. Air Force, Europe (LGT)
APO New York, NY 09012

Headquarters
U.S. Air Force, Pacific (LGT)
Hickam Air Force Base, HI 96853

Headquarters
Air Force Logistics Command (DST)
Wright Patterson Air Force Base, OH 45433

Headquarters
Air Force Systems Command (LGT)
Andrews Air Force Base, DC 20334

Headquarters
Strategic Air Command (LGT)
Offutt Air Force Base, NE 68113

Headquarters
Air Force Reserve (LGT)
Robins Air Force Base, GA 31098

Headquarters
Space Command (LGOT)
Peterson Air Force Base, CO 80914

Air Force Logistics Management Command (LGT)
Gunter Air Force Base, AL 36114

Air Force Operational Test and Evaluation Center (JT)
Kirtland Air Force Base, NM 87117

Air Force Institute of Technology (LSM)
Wright Patterson Air Force Base, OH 45433

3760 TCHTG/TTGBT
Sheppard Air Force Base, TX 76311

Commandant
U.S. Coast Guard
21090 Second St., SW
Washington, DC 20593

Commander
Fifth Coast Guard District
431 Crawford St.
Portsmouth, VA 23705