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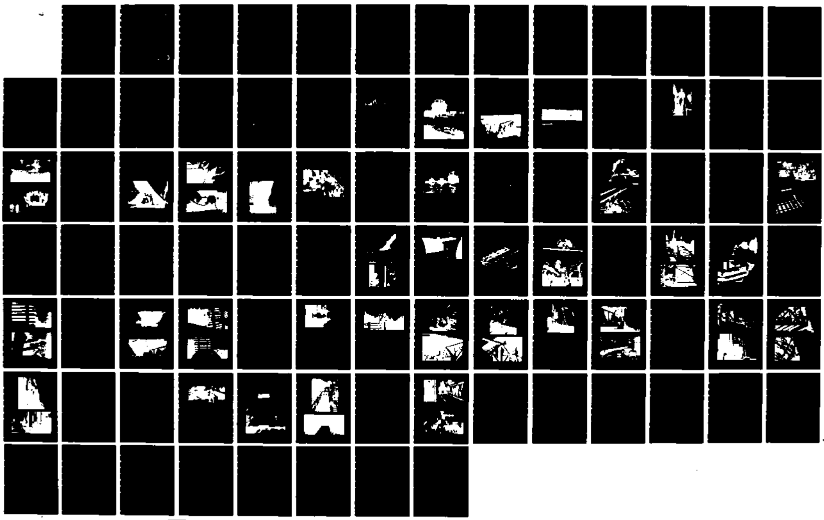

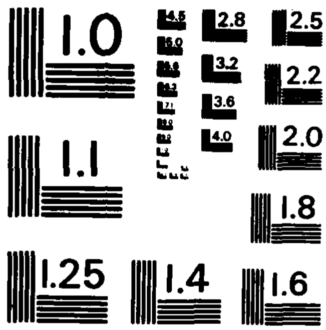


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# DAVID W. TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER

Bethesda, Maryland 20084

## ROLL-ON/ROLL-OFF (RO/RO) DISCHARGE FACILITY TESTS WITH MV CYGNUS AND SS ATLANTIC BEAR

(COTS CNO PROJECT 299, DT-IIF-1)

by

Theodore G. Vaughters

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SYSTEMS DEVELOPMENT DEPARTMENT

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NOVEMBER 1983

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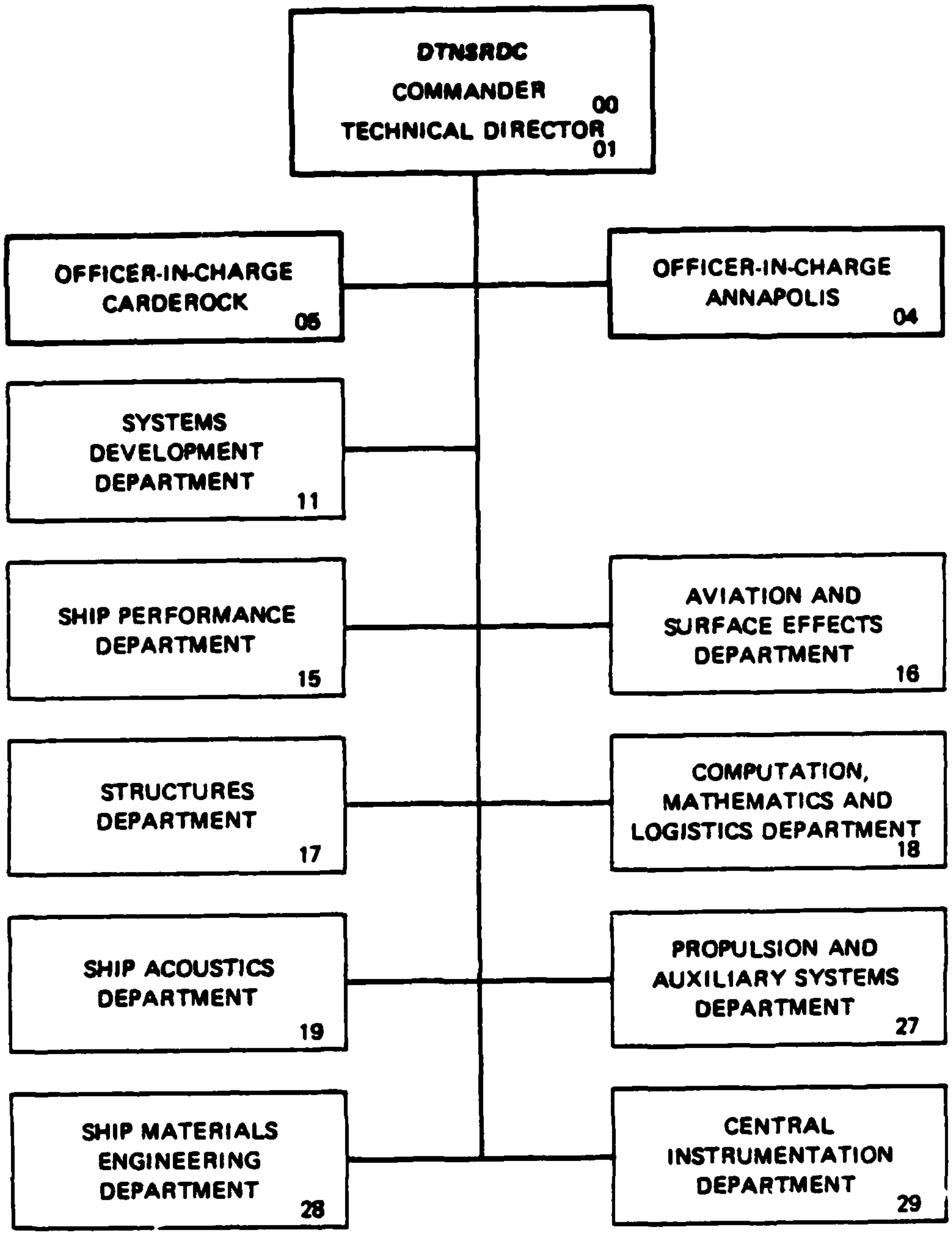

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| Calm water ramp | RO/RO offloading | |
| Causeway platform facility | Pontoon platform | |
| Causeway ferry | Vehicle discharge | |

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-The United States has long included merchant ships in plans to support Navy-Marine Corps Amphibious Assault Follow-On Echelon (AFOE) and Army Logistics Over-the-Shore (LOTS) operations. The shift toward port dependent cargo ships has generated the need for the military to investigate other methods/facilities to offload cargo without having to develop complex commercial type harbor facilities in the objective area. Military vehicular cargo such as the tanks, artillery trucks, trailers, and other rolling stock
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can be most efficiently transported to the objective area by U.S Flag Roll-On/Roll-Off (RO/RO) ships. The tests with the MV CYGNUS and SS ATLANTIC BEAR prove the viability of the RO/RO Discharge Facility concept for both off-loading and backloading of self-sustaining and nonself-sustaining RO/RO ships in an offshore setting under calm water conditions. Representative military vehicles were driven from the ships onto Causeway Ferries and Landing Craft, Utility (LCUs) for transfer to the beach. Ship backloading operations were also tested by reversing the ships' offloading sequence. Both ship tests, which were performed in conjunction with and during the Joint Logistics Over-the-Shore (JLOTS) II exercise, were designed to validate previously developed operational procedures and provide a means of further technical evaluation of the Navy's RO/RO Discharge Facility equipment. This report documents the technical evaluation of the test events, evaluates the results, and provides concluding recommendations.

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ABSTRACT

The United States has long included merchant ships in plans to support Navy-Marine Corps Amphibious Assault Follow-On Echelon (AFOE) and Army Logistics Over-the-Shore (LOTS) operations. The shift toward port dependent cargo ships has generated the need for the military to investigate other methods/facilities to offload cargo without having to develop complex commercial type harbor facilities in the objective area. Military vehicular cargo such as tanks, artillery trucks, trailers, and other rolling stock can be most efficiently transported to the objective area by U.S. Flag Roll-On/Roll-Off (RO/RO) ships. The tests with the MV CYGNUS and SS ATLANTIC BEAR prove the viability of the RO/RO Discharge Facility concept for both offloading and backloading of self-sustaining and nonself-sustaining RO/RO ships in an offshore setting under calm water conditions. Representative military vehicles were driven from the ships onto Causeway Ferries and Landing Craft, Utility (LCUs) for transfer to the beach. Ship backloading operations were also tested by reversing the ships' offloading sequence. Both ship tests, which were performed in conjunction with and during the Joint Logistics Over-the-Shore (JLOTS) II exercise, were designed to validate previously developed operational procedures and provide a means of further technical evaluation of the Navy's RO/RO Discharge Facility equipment. This report documents the technical evaluation of the events, evaluates the results, and provides concluding recommendations.

ADMINISTRATIVE INFORMATION

The developmental tests conducted with the MV CYGNUS and SS ATLANTIC BEAR and the RO/RO Discharge Facility are an integral part of the Naval Facilities Engineering Command (NAVFAC) program to develop methods for offloading military cargo from merchant ships. The NAVFAC program is CNO Project No. 299, Container Offloading and Transfer System (COTS). The program developmental test designation is DT-IIF-1. The program manager for the subject test is NAVFAC 032B. Technical program development and test direction were provided by the David W. Taylor Naval Ship Research and Development Center (DTNSRDC), Mobile Support Systems Office, Code 1190, Task Area Y0816.002 and Work Unit 1190-158, with the support of the Naval Civil Engineering Laboratory (NCEL), Amphibious and Harbor Division, Code L55, and Puget Sound Naval Shipyard, Code 280.3. The tests were accomplished by the Amphibious Construction Battalion Two (PHIBCB TWO), Little Creek, Virginia with support from the Marine Corps, U.S. Army, and the Joint Logistics Over-the-Shore Test Directorate.

# INTRODUCTION

## BACKGROUND

Department of Defense (DOD) level planning for the logistics support necessary to sustain major contingency operations, including Amphibious Assault Operation Landings and Logistics Over-the-Shore (LOTS) evolutions, relies extensively on the utilization of U.S. Flag commercial shipping assets. The recent trends in commercial shipping have been increasing toward containerships, Roll-On/Roll-Off (RO/RO) ships, and barge ships (e.g., LASH, SEABEE).

Amphibious assault operations or LOTS contingency operations are usually conducted over undeveloped beaches where port facilities are not available. Therefore, DOD is faced with the problem of offloading its military cargo from the various classes of transmodal ships and moving the cargo inland.

A significant amount of the Assault Follow-On Echelon (AFOE) equipment consists of vehicles or equipment ultimately intended to be carried on a vehicle. For this reason, RO/RO ships are ideally suited to AFOE support. Loading and unloading vehicles on the RO/RO ships is currently done, however, only from/to a pier facility not usually available at an assault beach. A requirement exists to offload vehicles from a RO/RO ship to an undeveloped assault beach in order to make optimum use of U.S. Flag assets in AFOE support. Engineering studies and investigations were completed to satisfy this requirement. These studies and investigations recommend that offloading operations utilize an intermediate platform from which lighters would transfer the cargo to the beach[1*]. Model experiments were conducted to evaluate the performance of several floating platform configurations made from connecting individual causeway sections together to form a sufficiently large platform to support the ship's ramp and allow drive-off of vehicles from the ship. These model experiments concluded that a platform configuration of six causeway sections connected in two rows by three abreast (2 x 3) was superior to all the other platform configurations examined[2]. This

*A complete listing of references is given on page 79.

2 x 3 platform has been named the Causeway Platform Facility (CPF).

Several offloading facility tests with the CPF were accomplished in 1982 involving two basic classifications of RO/RO ships; self-sustaining and nonself-sustaining, i.e., those ships which have their own offloading ramps (self-sustaining) and those which do not have their own offloading ramps (nonself-sustaining). As a result of these 1982 t .s a number of equipment design improvements were made and operationa procedures were refined[3,4,5].

PURPOSE

The purpose of the technical evaluation with the MV CYGNUS was to evaluate the CPF interface relationship with a self-sustaining RO/RO ship by evaluating CPF ancillary equipment designs and validating procedures developed and demonstrated during the September 1982 developmental test[4]. The SS ATLANTIC BEAR test was used to develop and demonstrate a viable and practical method for offloading military cargo from a nonself-sustaining merchant RO/RO ship in a setting resembling an undeveloped assault beach. The demonstration of the CPF, with its special fenders and portable Calm Water Ramp (CWR), and their interface relationship with a nonself-sustaining RO/RO vessel represents the primary purpose of the test with the SS ATLANTIC BEAR.

TEST PLAN

The basic variables of the MV CYGNUS and SS ATLANTIC BEAR offloading facility developmental test plans* included:

CPF/Ship Interfaces

- CPF at stern ramp of MV CYGNUS
- CPF/CWR at aft side port of SS ATLANTIC BEAR
- CPF/CWR at a transom port (contingency) of SS ATLANTIC BEAR

---

*Detailed in enclosures 1 (COTS Drive-Off Methods, CYGNUS/CPF Test Plan) and 2 (COTS Drive-Off Methods-PONCE, LURLINE/GREAT LAND Class RO/RO Ships Test Plan) to DTNSRDC letter 1190:TGV 3960 of 1 June 1983.

Lighterage Interface with CPF

- Causeway Ferry married at side position
- LCU married at center without Causeway Ferry married at side
- LCU married at center with Causeway Ferry married at side

Weather/Environment (desired)

- Sea State range 0 to 2
- Varying winds and tidal currents

TEST SETTING

The setting for the tests with the MV CYGNUS and the SS ATLANTIC BEAR was the southern edge of the mouth of the Chesapeake Bay between Cape Henry and the Chesapeake Bay Bridge Tunnel. The actual ship moorages are shown in Figure 1. The test site was chosen for its water depth and its proximity to both the Naval Amphibious Base at Little Creek, Virginia and Fort Story (Cape Henry, Virginia), site of JLOTS II.

TEST OBJECTIVES

The overall objective of the developmental tests with the self-sustaining RO/RO (i.e., MV CYGNUS) was to evaluate CPF ancillary equipment designs and validate procedures developed and demonstrated during the September 1982 tests[4]. Specifically:

1. To confirm that the CPF can be positioned and moored adequately in a "stand-off" arrangement.

2. To confirm the number of warping tugs/tender boats required to assemble, transport, position and maintain the CPF in the "stand-off" arrangement.

3. To determine the suitability of the ramp hydraulic station protection gear.

4. To evaluate the deck closure plates.

5. To evaluate the procedures set forth in the system technical manual[6] and other systems support documentation.

6. To evaluate LCU/ bow marriage procedures as an administrative interest item.

The specific test objectives for the nonself-sustaining RO/RO (i.e., SS ATLANTIC BEAR) offloading facility tests were:

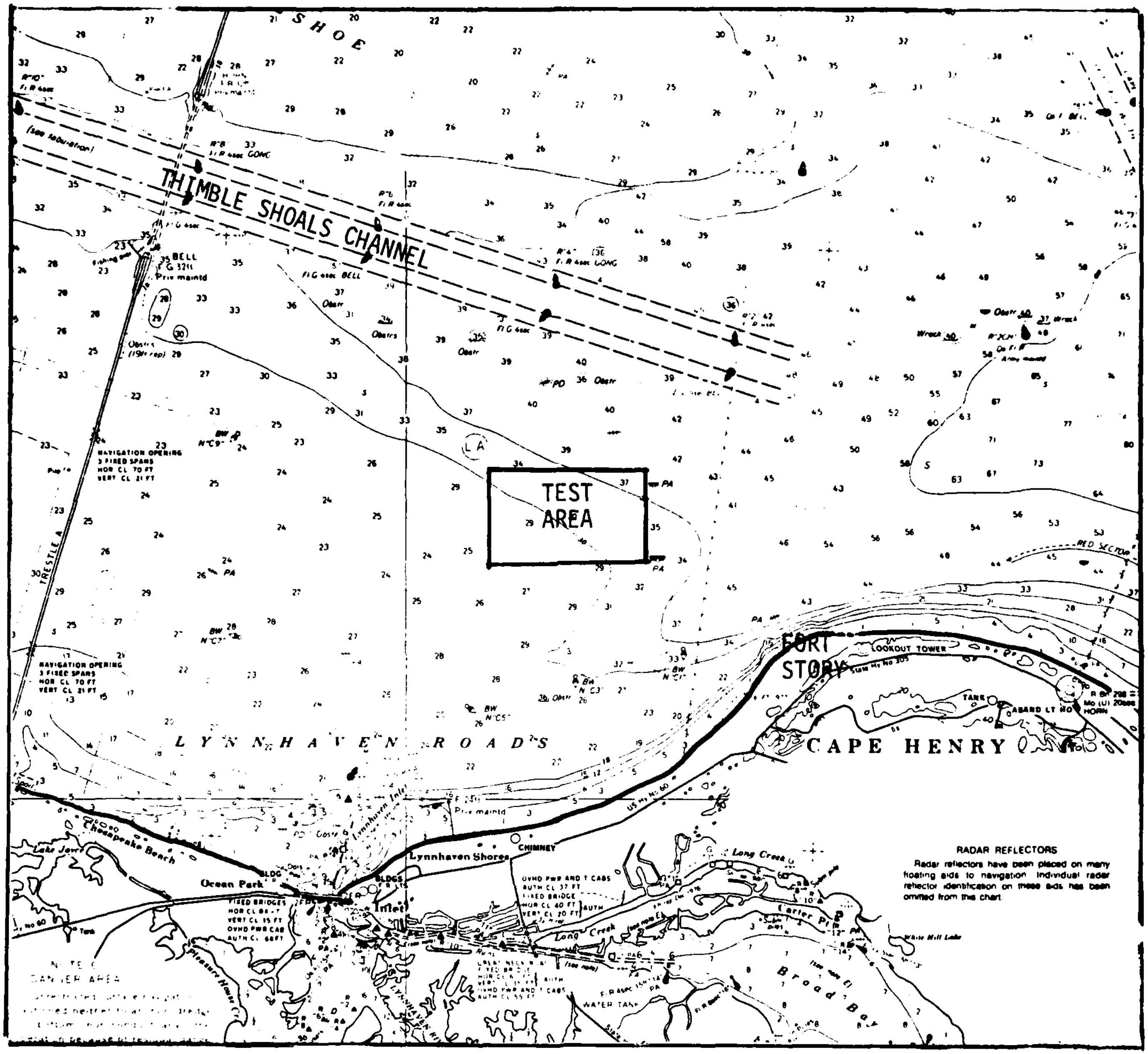



Figure 1 - Test Setting

1. To confirm that the CWR and CPF assembly procedures were adequate.

2. To establish the minimal number of resources (equipment, personnel, warping tugs/tender boats, etc.) required to assemble, transport, position and moor the CPF at selected offloading ports (transom and/or side port).

3. To determine the suitability of raising the CWR to the ship's offloading ports and securing it to the ship using the ship's existing ramp handling winches.

4. To determine the suitability of the ship's existing ramp pendants and related ship equipment to support and align the ship's end of the CWR.

5. To determine if Causeway Ferries/LCUs can be properly secured to the causeway platform while the causeway platform is moored to the ship and with the CWR attached to the ship's offloading port.

6. To determine if the test vehicles can be safely offloaded from representative shipboard vehicle stowage onto Causeway Ferries/LCUs.

7. To determine if the test vehicles can be safely retrograded onto the ship.

8. To assess vehicle performance when transiting an inclined CWR from the causeway platform to the ship and when transiting from the ship to causeway platform.

9. To evaluate the load carrying capability of the CWR and its related ramp supporting apparatus.

10. To assess all of the test objectives under a dynamic test environment to better define sea state/relative motion limitations in Sea State 0-2 conditions.

11. To evaluate the procedures of the system technical manual[6] and other system support documentation.

MERCHANT RO/RO SHIPS

At present, the operating American-owned merchant RO/RO ships are the USNS COMET, USNS METEOR, ADMIRAL WILLIAM M. CALLAGHAN, DEFIANCE Class (four ships), MAINE Class (four ships), PONCE/LURLINE Class (five ships), GREAT LAND Class (five ships), MV CYGNUS, and LYRA.

The USNS COMET, USNS METEOR, ADMIRAL WILLIAM M. CALLAGHAN, and DEFIANCE Class ships have complete gear for conventional break-bulk cargo handling in addition to their RO/RO capability. The DEFIANCE Class ships are used primarily as container carriers with limited RO/RO capacity. The MAINE Class ships are primarily RO/RO container carriers (containers loaded by special forklift trucks), but tie-down fittings are provided for vehicular cargo. The PONCE/LURLINE and GREAT LAND Classes are trailer ships. Three new RO/RO ships are being built for Waterman Steamship Corporation. They will be about the size of the MAINE Class and will be fitted with stern slewing ramps. In addition to these, there are other RO/RO ships of the MAINE type (but smaller), and numerous conventional RO/RO ships are owned by allied countries.

A number of merchant RO/RO ships are under contract to the Military Sealift Command (MSC). Two ships of the MAINE Class (USNS JUPITER and USNS MERCURY) are operated by MSC as part of the U.S. Near Term Prepositioned Ships Program. Other MSC operated RO/RO ships include the USNS METEOR, MV CYGNUS, and LYRA. In addition, the Navy is in the process of acquiring/modifying RO/RO ships for the Maritime Prepositioning Force (TAKX) and for the Rapid Deployment Force (TAKRX).

At present the operating American-owned merchant self-sustaining RO/RO ships (i.e., those with their own vehicle embarkation/debarkation ramps) are the USNS COMET, USNS METEOR, ADMIRAL WILLIAM M. CALLAGHAN, MV CYGNUS, LYRA, DEFIANCE Class (four ships), and MAINE Class (four ships). These ships represent a total available vehicle stowage area of approximately 1,300,000 square feet. The PONCE/LURLINE Class (five ships) and GREAT LAND Class (five ships) are the only nonself-sustaining RO/RO ships (i.e., those without their own vehicle embarkation/debarkation ramps) representing a total available vehicle stowage area of approximately 1,800,000 square feet. Therefore, of the total available vehicle stowage, approximately 42% is on self-sustaining RO/ROs and 58% is on nonself-sustaining RO/ROs. These percentages will change significantly when the TAKX and TAKRX vessels become operational since all of these ships will be self-sustaining. At that time approximately 73% of the total available vehicle stowage will be on self-sustaining U.S. Flag RO/ROs (see Table 1).

RO/RO SHIP CAPACITY COMPARISON

| TYPE OF RO/RO | Non Self-Sustaining RO/RO | Self-Sustaining RO/RO | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| CLASS<br>NUMBER OF SHIPS | PONCE/LURLINE & GREAT LAND CLASS<br>(10) | METEOR COMET<br>(2) | ADM CALLAGHAN<br>(1) | AMERICAN EAGLE<br>(1) | DEFIANCE CLASS<br>(4) | MAINE CLASS<br>(4) | CYGNUS LYRA<br>(2) | TAKX (General Dynamics)<br>(5) | TAKX (Maersk)<br>(5) | TAKX (Waterman)<br>(3) | TAKRX SL-7<br>(8) |
| TOTAL SQ FT | 1,805,500 | 183,000 | 167,537 | 179,192 | 136,000 | 637,688 | 226,000 | 812,500 | 600,400 | 457,572 | 1,356,800 |
| % of TOTAL | 27 | 3 | 3 | 3 | 2 | 10 | 3 | 12 | 9 | 7 | 21 |
| TOTALS | 27% | 73% | | | | | | | | | |

Table 1 - RO/RO Ship Capacity Comparison

The MV CYGNUS represented an ideal self-sustaining RO/RO for testing since its offloading ramp is almost identical to other stern slewing and stern quarter ramps on other self-sustaining RO/ROs. The SS ATLANTIC BEAR represented the ideal nonself-sustaining ship for testing as it is a GREAT LAND Class vessel and is fitted with offloading ports along both the starboard side and transom. PONCE/LURLINE ships do not have transom offloading ports. Other characteristics of the MV CYGNUS and SS ATLANTIC BEAR are noted in the Inboard Profile and Plan Views, Figures 2 and 3, and the RO/RO Ship Characteristic Chart, Table 2.

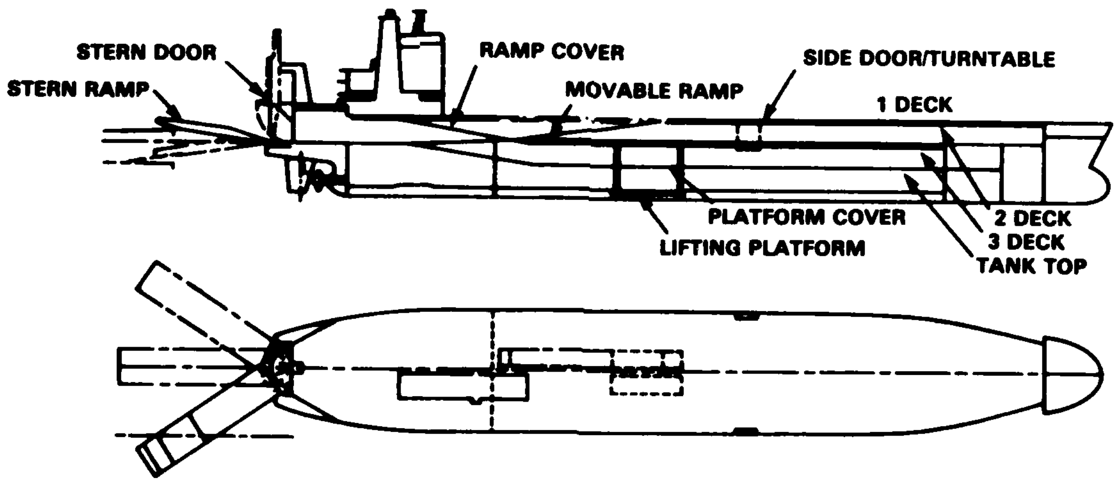



Figure 2 - MV CYGNUS Inboard Profile and Plan Views

| TYPE OF RO/RO | SELF-SUSTAINING | | | | | | | | | | | NONSELF-SUSTAINING | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SHIP CLASS | RABENFELS | REICHENFELS | CALLAGHAN | MAINE | COMET | METEOR | DEFIANCE | TAKX GENERAL DYNAMICS | TAKX BETH SHIP MAERSK "E" CONVERSION | TAKX WATERMAN | T-AKR(X) SL(7) CONVERSION | PONCE/LURLINE | GREAT LAND |
| Ships Available | 1 | 1 | 1 | 4 | 1 | 1 | 4 | 5 | 5 | 3 | 8 | 5 | 5 |
| Ships Names | CYGNUS | LYRA | ADM. WM. M CALLAGHAN | USNS JUPITER<br>USNS MERCURY<br>TYSON LYKES<br>CHARLES LYKES | USNS COMET | USNS METEOR | DEFIANCE<br>RED JACKET<br>GREAT REPUBLIC<br>YOUNG AMERICA | UNDER CONSTRUCTION/CONVERSION | | | | PONCE<br>BAYAMON<br>PUERTO RICO<br>LURLINE<br>MATSONIA | GREAT LAND<br>FORTALEZA<br>CAGUAS<br>ATLANTIC BEAR<br>WESTWARD VENTURE |
| Length m(ft) | 193 (634) | 193 (634) | 212 (694) | 212 (684) | 152 (499) | 165 (540) | 183 (602) | 187 (614) | 215 (705) | 233 (766) | 268 (800) | 213 (700) | 241 (790) |
| Breadth m(ft) | 27 (89) | 27 (89) | 28 (92) | 31 (102) | 24 (78) | 25 (83) | 27 (90) | 32 (106) | 27 (90) | 32 (106) | 32 (106) | 32 (105 | 32 (105) |
| Draft m(ft) | 9 (30) | 9 (30) | 8 (27) | 10 (32) | 7 (22) | 7 (24) | 9 (31) | 9 (29) | 10 (33) | 10 (32) | 10 (34) | 9 (28) | 9 (28) |
| Speed (knots) | 21.4 | 21.4 | 25 | 23 | 18 | 22 | 25 | 18 | 17.5 | 20 | 30 | 24 | 24 |
| Clear Deck Area $m^2$($ft^2$) | 10,500 (113,000) | 10,500 (113,000) | 15,600 (167,500) | 14,800 (159,400) | 7,800 (84,000) | 9,200 (99,000) | 3,200 (34,000) | 15,000 (162,500) | 11,200 (120,080) | 14,200 (152,500) | 15,800 (169,600) | 13,900 (150,000) | 19,600 (211,100) |
| Ship Offloading Ramp Type | Stern Slewing | Stern Slewing | Stern | Stern Quarter | Stern | Stern | Stern | Stern Slewing Ramp | Stern Semi-Slewing 2 Sideport Ramps | Stern Slewing Ramp | Side Ramp One Port, One Stbd Attached to hinged platform | None (Shore) | None (Shore) |

Table 2 - RO/RO Ship Characteristics

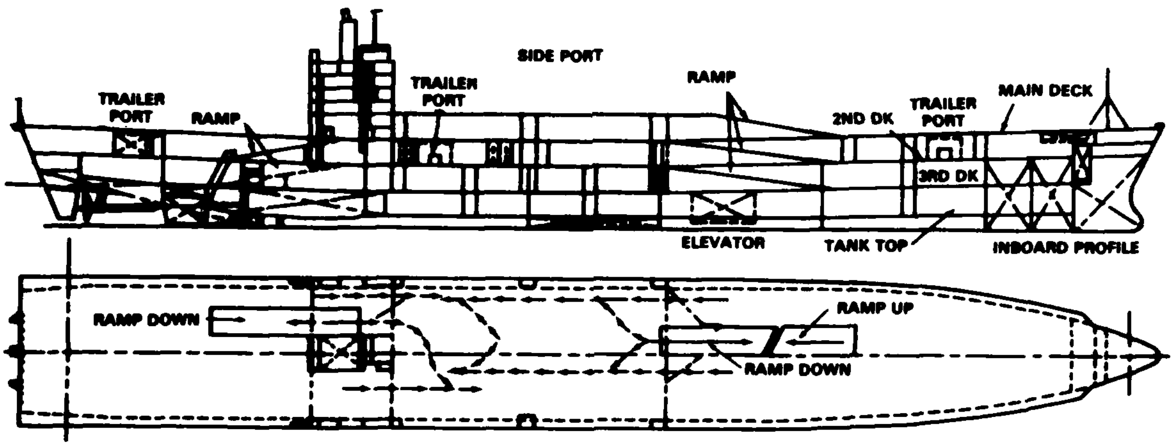


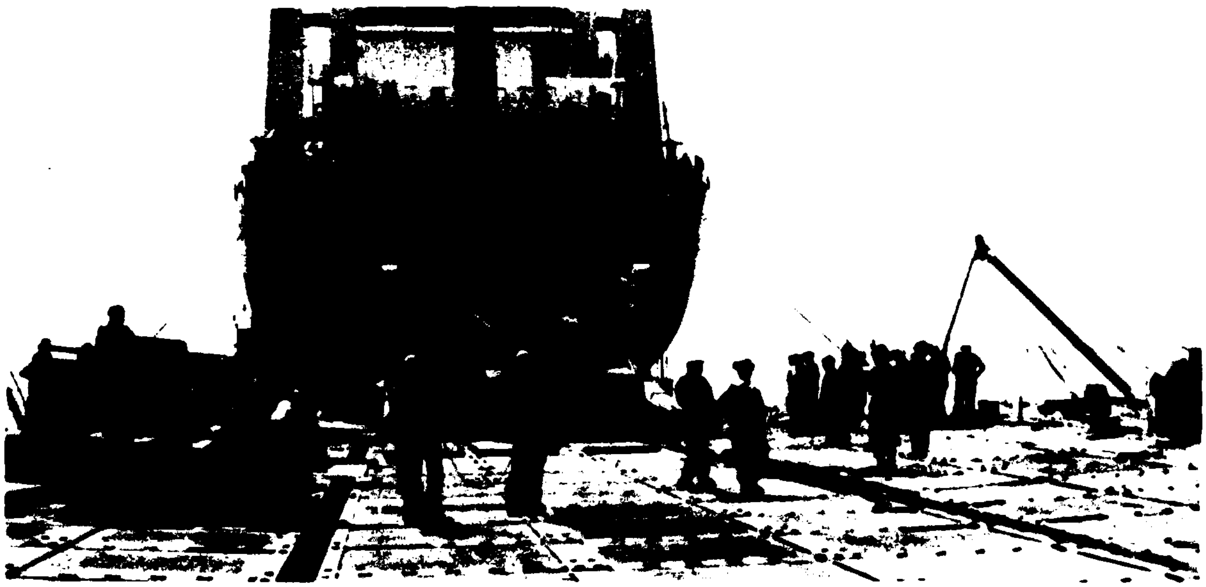

Figure 3 - SS ATLANTIC BEAR Inboard Profile and Plan Views

REPRESENTATIVE MILITARY VEHICLES

In order to adequately test the CPF and CWR concept under extreme loading conditions approximately 100 of the heavier, larger, and more difficult to handle vehicles were chosen for loading/offloading the MV CYGNUS and SS ATLANTIC BEAR. The vehicles were chosen by Marine Corps and Army personnel as representative for the planned loading/offloading evolutions of the JLOTS II Test[7]. The test vehicles include: an M88 tank retriever, an M198 howitzer, 25 ton container handlers, a LACH, and numerous trucks, trailers, forklifts, and other support equipment.

CAUSEWAY PLATFORM FACILITY (CPF)

The causeway platform facility is comprised of six standard causeway sections joined together by flexor connectors to form a platform 65 ft wide and 180 ft long. Figure 4 shows the CPF at the MV CYGNUS. With the exception of several pieces of ancillary equipment for the CPF, all of the equipment used in the MV CYGNUS test had been previously tested and evaluated[4].



CAUSEWAY PLATFORM FACILITY

Figure 4 - Causeway Platform Facility (CPF) at the MV CYGNUS

New equipment to be evaluated consisted of the following:

1. Closure plates to bridge the approximately 14-in. gap between the side-connected causeway sections.

2. Wire rope mooring pendants to facilitate the attachment of the CPF mooring lines to the external padeyes located near the waterline at the stern of the ship.

3. Field erected pipe cages for ramp hydraulic station protection.

4. B section rhino horns for LCU bow marriages.

In addition to the standard CPF equipment for a self-sustaining vessel, the CPF requires CPF-to-ship fenders and the CWR for operations with a nonself-sustaining vessel. Figure 5 shows this arrangement at the SS ATLANTIC BEAR.

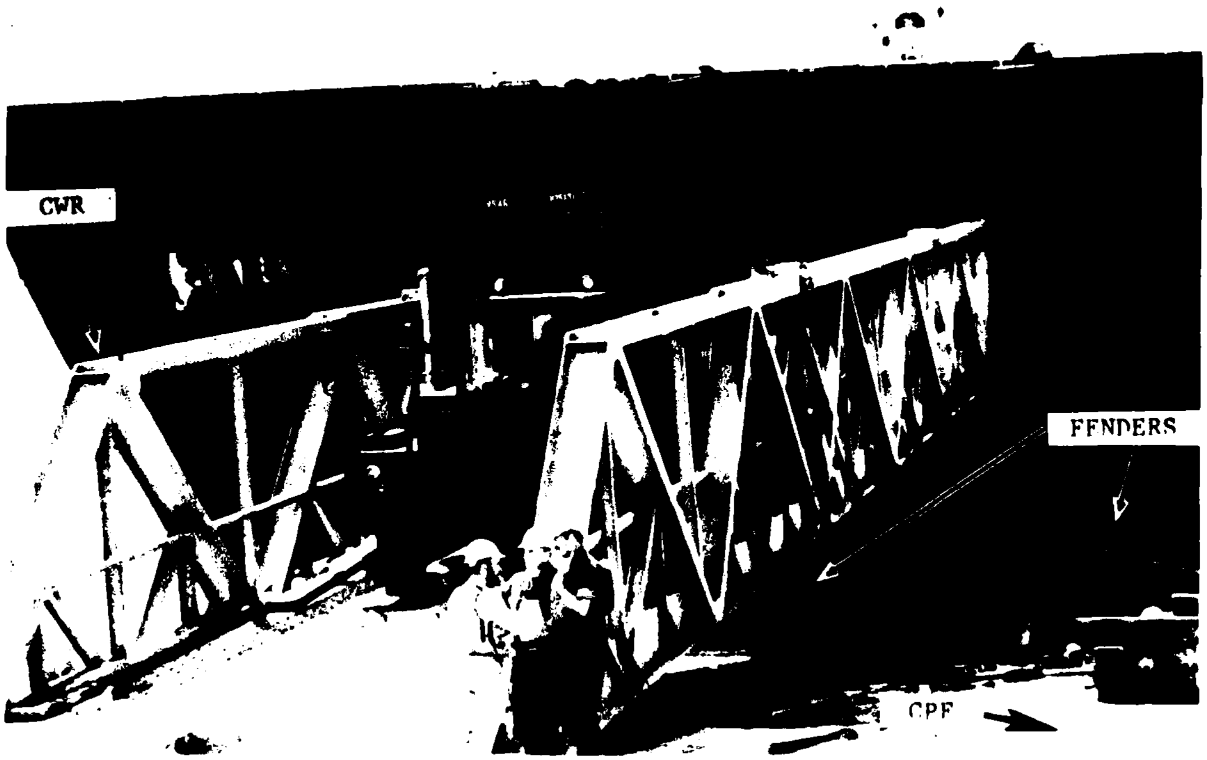



Figure 5 - CPF with CWR and Fenders at the SS ATLANTIC BEAR

CPF-TO-SHIP FENDERS

Three fender assemblies, Figure 6, are required to fend off the CPF from the ship's side or transom. These fender assemblies were previously tested in a simulated side port mooring during tests with the SS AMERICAN TROJAN[5].

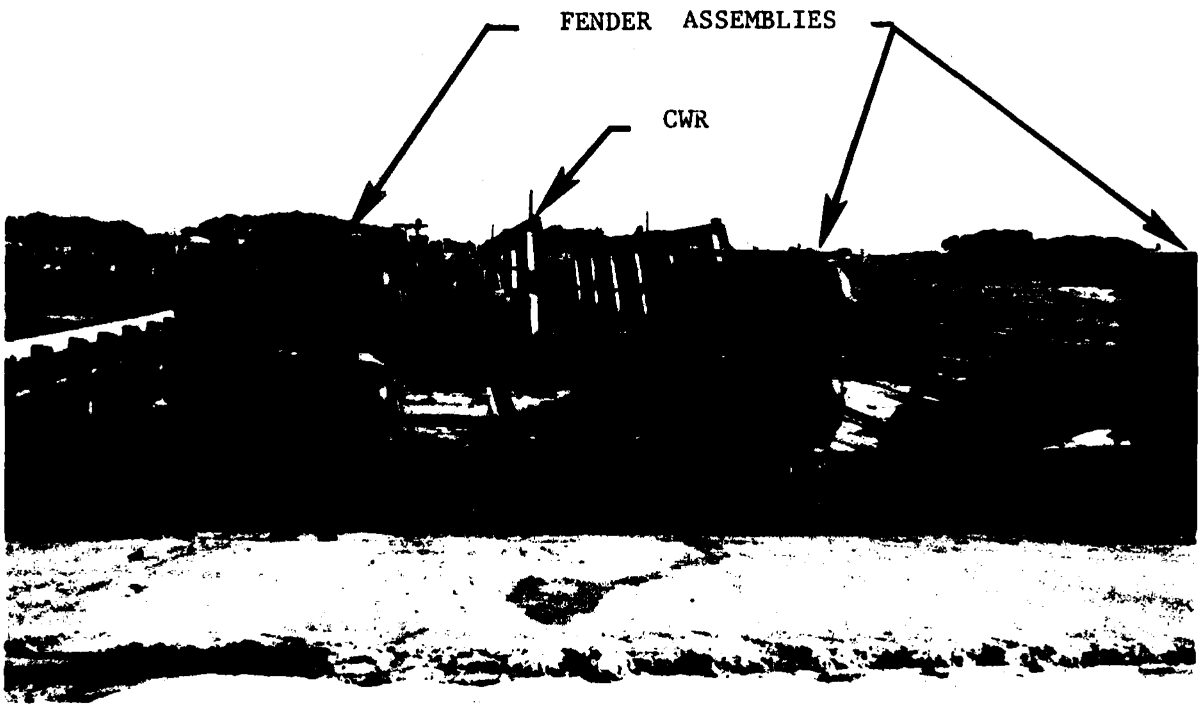



Figure 6 - CPF Fender Assemblies

CALM WATER RAMP (CWR)

The CWR, Figure 7, is required to hook up to the ship's offloading port so that the vehicular cargo may drive off. It is the facility's equivalent of the shore-based ramp that would normally be used for loading/offloading at a pier. It is 120 ft long with a clear roadway width of 14 ft. It is pulled into position using the ship's four winch system and held there by two large Z-brackets and support pendants, Figure 8. The total weight of the ramp and brackets is 152,000 lb. Developmental tests of the CWR were conducted during the summer of 1982[3,5].

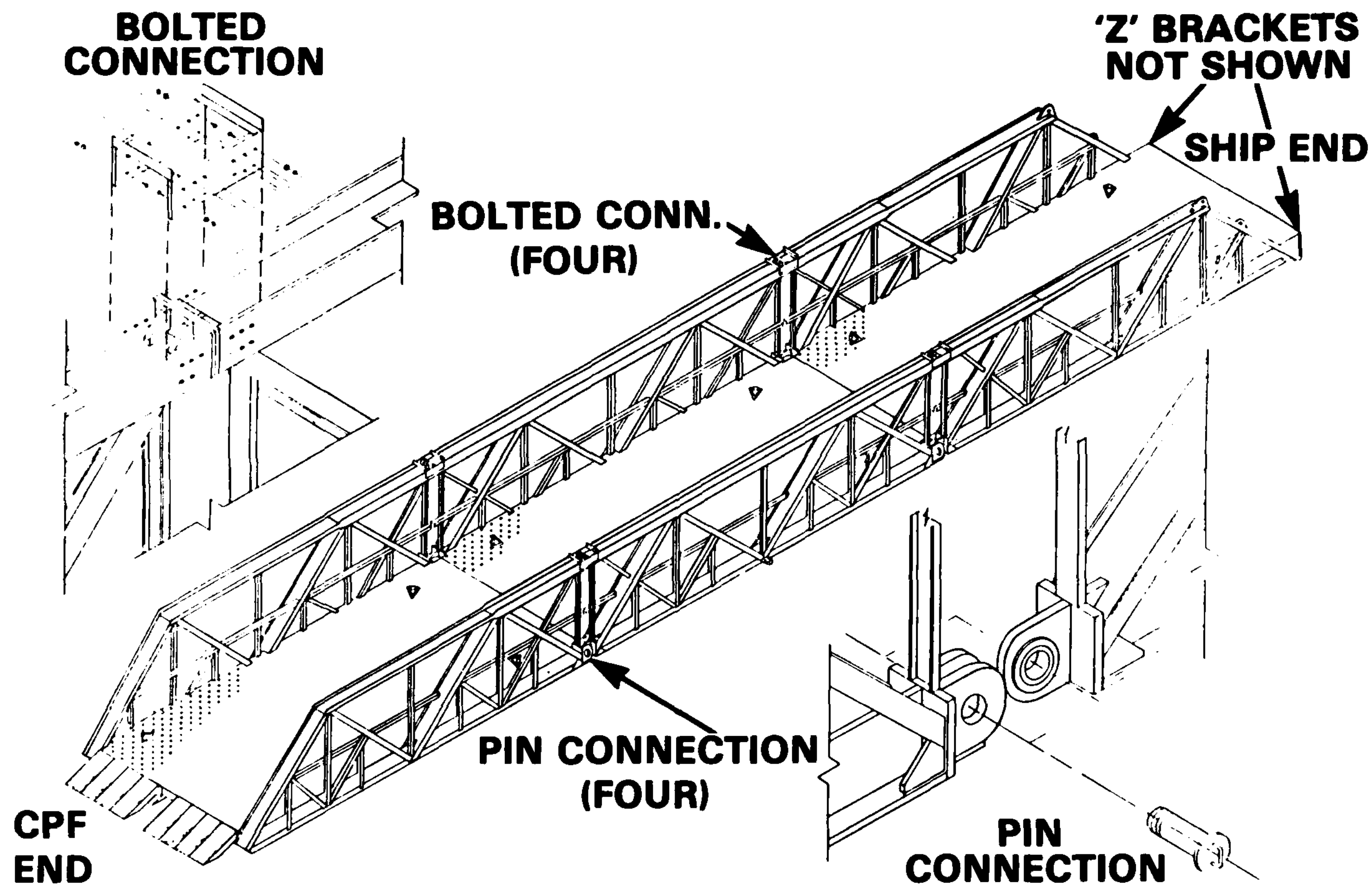



Figure 7 - Calm Water Ramp (CWR)

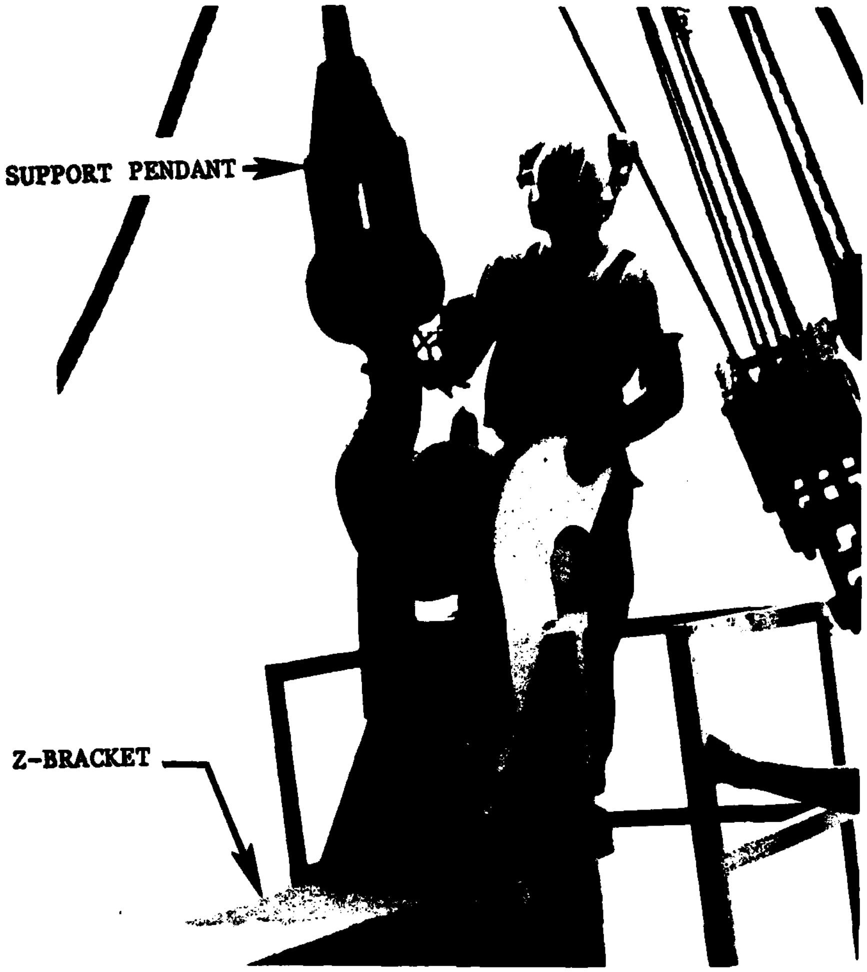



Figure 8 - CWR Z-Bracket and Support Pendant

CAUSEWAY FERRIES, LCU, WARPING TUGS

Standard four section Causeway Ferries and LCUs were used for the test. LCM6s were used as the primary motive power for the Causeway Ferries. Warping tugs were used to move the CPF and maintain platform orientation and provided some assistance to Causeway Ferries as they were marrying to the CPF. The Causeway Ferries, CPF warping tugs, CPF ancillary equipment and beach support equipment make up the RO/RO discharge facility.

TESTING INSTRUMENTATION PLAN

In order to fully evaluate the MV CYGNUS AND SS ATLANTIC BEAR offloading facility test results, a fully equipped instrumentation trailer was utilized to measure environmental conditions and the response of the ship, CPF, and CWR. The following types of data were recorded and documented[7,8]:

a. Wave height

b. Current speed and direction

c. Wind speed and direction

d. Platform yaw, roll and pitch at SS ATLANTIC BEAR

e. CWR accelerations

f. Latitude and longitude

SCHEDULE OF TEST EVENTS

The MV CYGNUS/CPF tests were conducted 11-16 July 1983 and the SS ATLANTIC BEAR/CPF/CWR test were conducted 13-20 September 1983 in conjunction with the JLOTS II exercise. The major Developmental Tests (DT) took place on 12 July and 16-17 September.

The following is a brief schedule of the MV CYGNUS/CPF tests:

11 July - CPF Assembly off Anzio Beach, Naval Amphibious Base, Little Creek.

12 July - CPF moored at stern of anchored MV CYGNUS. Ship's stern ramp lowered onto CPF. Offload vehicles via Causeway Ferries. Ship's ramp raised and CPF removed.

13-16 July - Same as for 12 July except various lighterage mixes used for vehicle offloading and backloading such as a mix of Causeway Ferries and LCUs and LCUs alone.

The following is a brief schedule of the SS ATLANTIC BEAR/CPF/CWR tests:

13 September - CPF/CWR assembly test off Anzio Beach, Naval Amphibious Base, Little Creek.

14 September - SS ATLANTIC BEAR towed and moored in position. CPF/CWR tests cancelled due to rough seas.

15 September - Tests cancelled for the day due to continuing rough seas.

16 September - CPF/CWR brought alongside SS ATLANTIC BEAR but mooring does not take place due to excessive sea state.

17 September - CPF moored to SS ATLANTIC BEAR, CWR raised and attached to aft side port. Vehicles backloaded aboard

ship from LCUs and Causeway Ferries via CPF and CWR. CWR kept in position for the next 60 hrs.

18 September - Loading/Offloading operations continued.

19 September - Loading/Offloading operations continued.

20 September - CWR lowered, CPF removed then moored again, CWR raised. CWR lowered and CPF removed. SS ATLANTIC BEAR weighs anchor and towed back to Hampton Roads. Test completed.

## SUMMARY OF TEST RESULTS

### SUMMARY OF MV CYGNUS TEST

#### Test Objective 1

To confirm that the CPF can be positioned and moored adequately in a "stand-off" arrangement at a self-sustaining RO/RO.

Test Results. The CPF was positioned and moored to the ship all five test days. The CPF was moved from an offshore anchorage location to the ship's stern by two warping tugs. The tugs brought the CPF up against the transom of the ship and maintained forward propulsion to keep the CPF in contact with the ship during the passing of the mooring lines. The shear connectors on the end of the CPF caused some superficial damage to the ship's transom. A small area of paint was scraped away and a few metal gouges (1/16 in. or less) occurred, as shown in Figure 9. Later in the test, several tires were tied together on the end of the CPF to provide a simple fender. This addition worked well and eliminated any additional CPF/ship structural contact. The actual stern mooring arrangement used during the test is shown in Figure 10 and 11.

The positioning of the platform in a stand-off arrangement was readily accomplished with two warping tugs.

In order to facilitate the attachment of the CPF mooring lines to the external padeyes located near the waterline at the stern of the MV CYGNUS four wire rope mooring pendants were installed on the padeyes (see

Figure 9 - MV CYGNUS Transom Area Contacted by the CPF

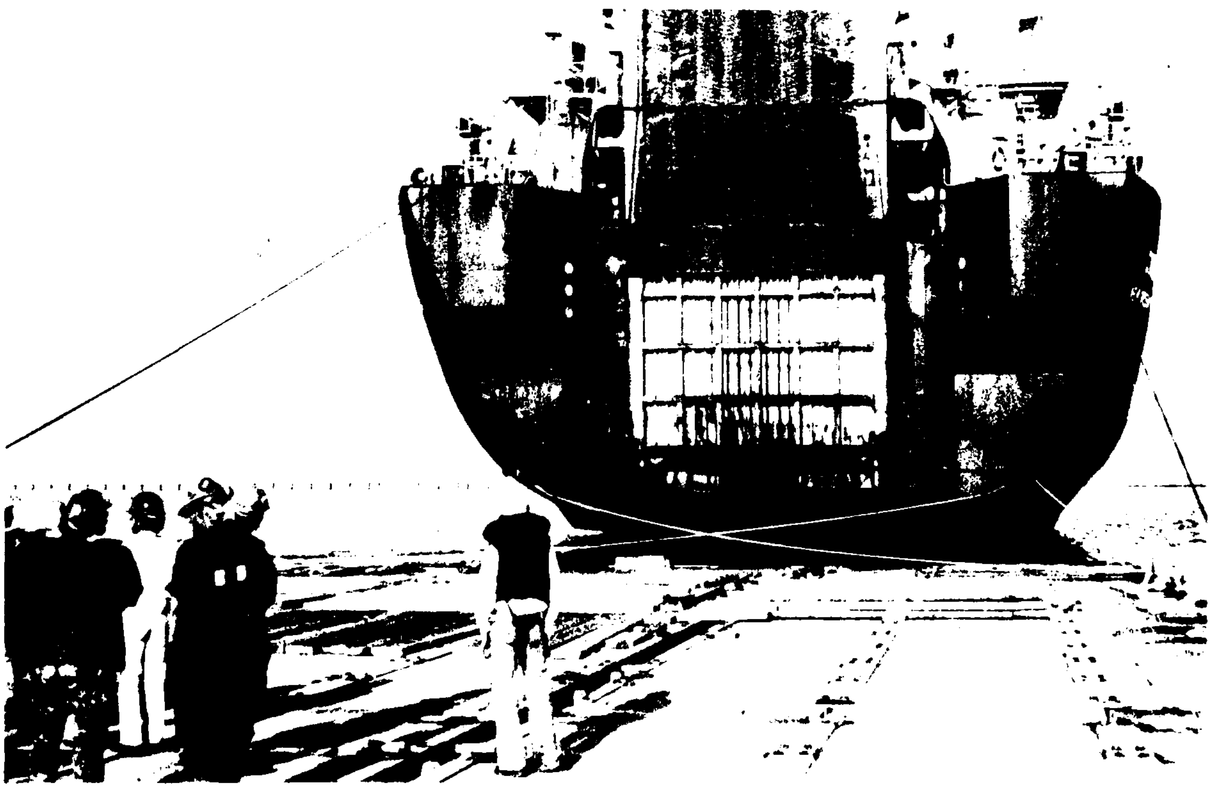


Figure 10 - CPF Mooring to MV CYGNUS

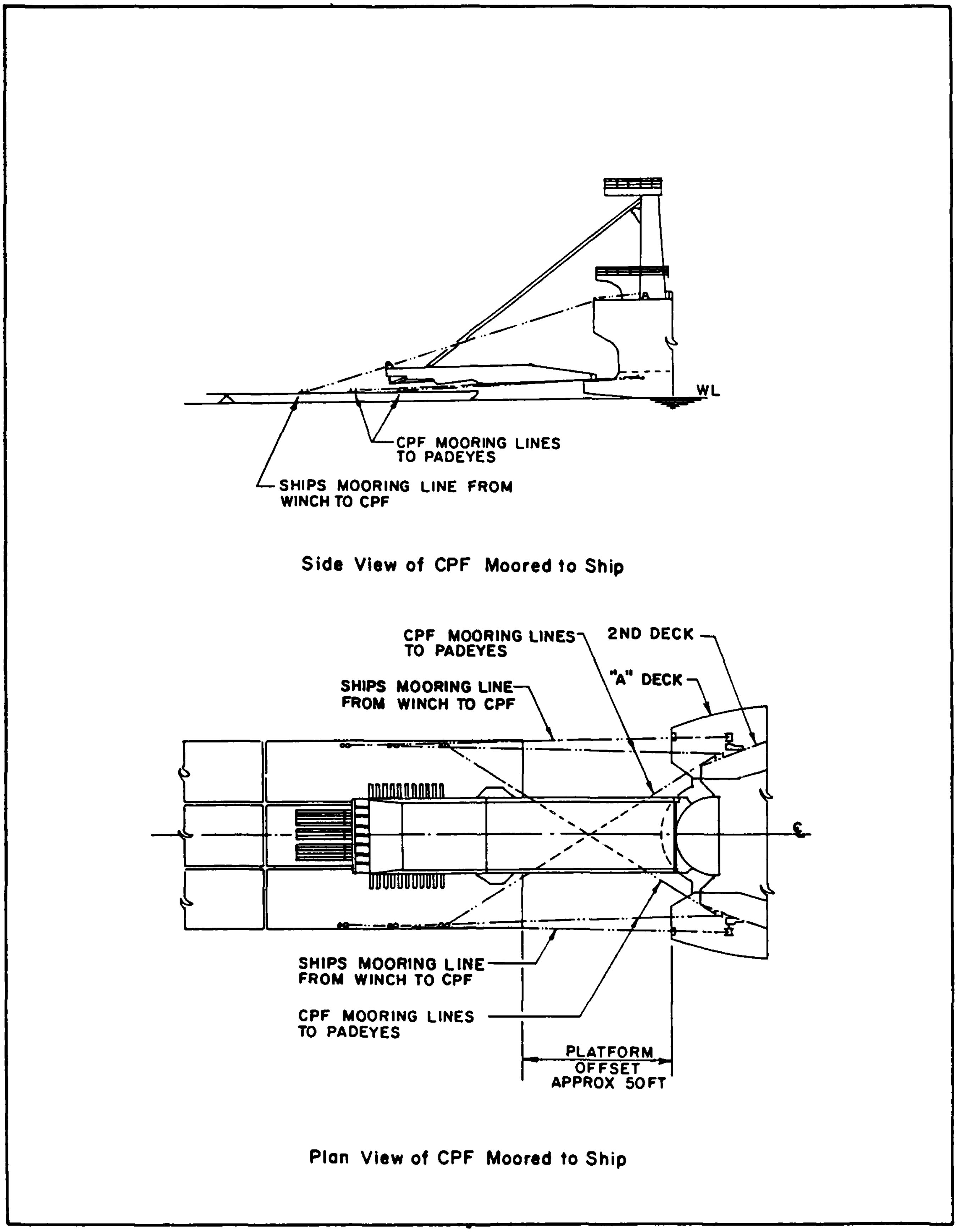



Figure 11 - CPF Mooring Diagram at MV CYGNUS

Figure 12). This permitted a simple shackle connection to the loop in the five in. double braded nylon line which in turn aided in engaging and disengaging the mooring lines to the ship. The wire rope thimbles at the ship's padeyes failed to remain perpendicular to the padeyes which resulted in partial damage of the thimble (see Figures 13 and 14) which caused the thimbles to become wedged on the padeye. This was not a problem until the pendants were removed at which time a boat hook was needed to free them.

Figure 12 - Installation of Mooring Pendants

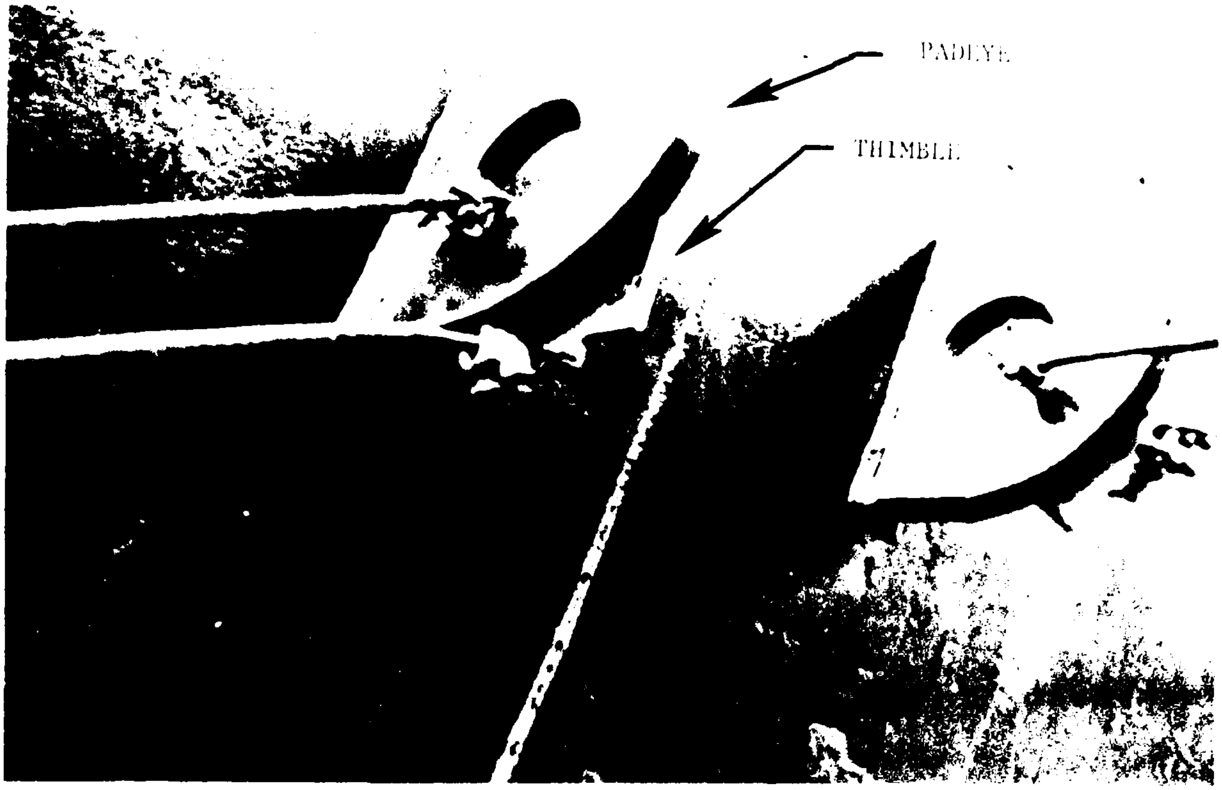



Figure 13 - Pendant Thimbles Laid Over Against Padeyes

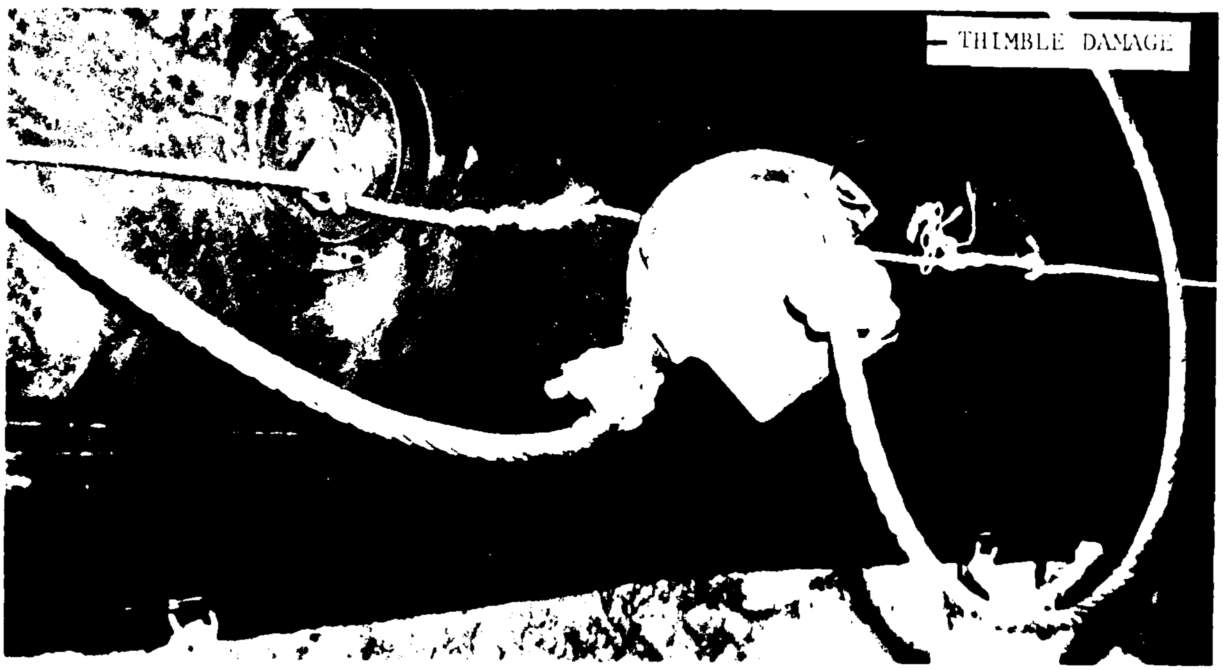



Figure 14 - Mooring Pendant Thimble Damage

The attachment of the mooring pendants to the ship's padeyes was accomplished faster and with less difficulty by the use of a hard-bottomed, inflatable dinghy (Zodiac). The relatively close position with respect to the padeyes was more easily maintained with the small craft than in previous tests[4] where an LCM 6 was used.

At the conclusion of the first day of tests, the CPF mooring lines were left attached to the external padeyes and the free ends were passed to the ship where the lines were staged for the next day's operations. This simplified the mooring operations during the remaining days of operation, which necessitated only the passing down of the lines from the ship (see Figure 15).

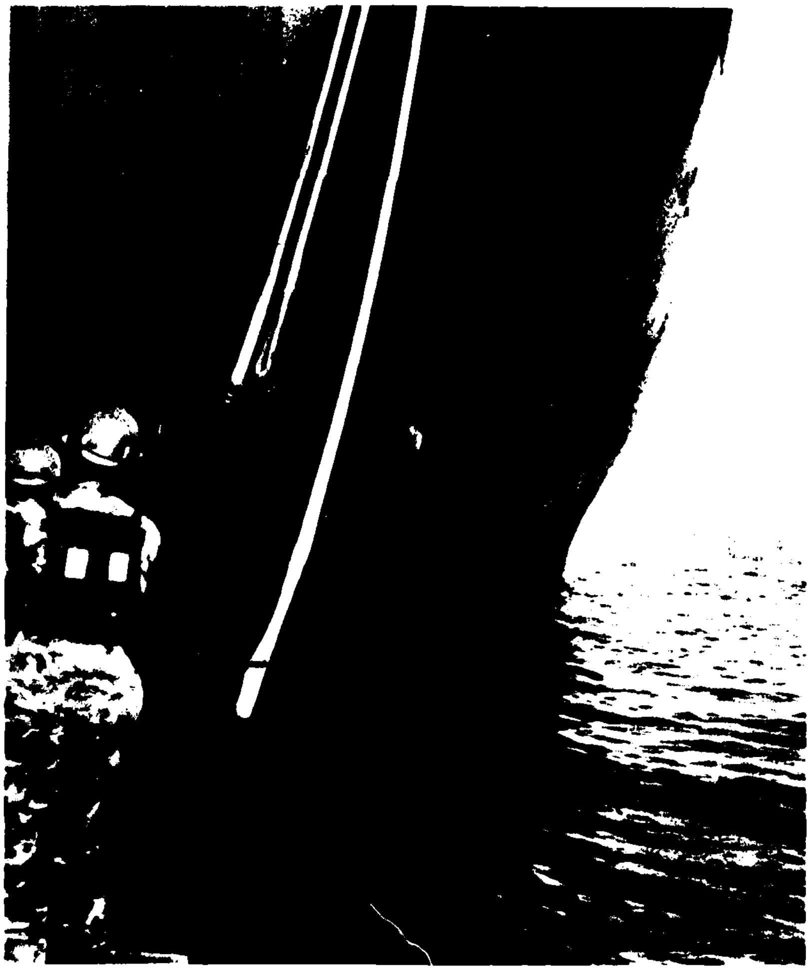


Figure 15 - Passing of CPF Mooring Lines

In addition to the mooring lines provided by the CPF, two of the ship's aft mooring lines and winches were used to secure the platform. These were shown in Figures 10 and 16.

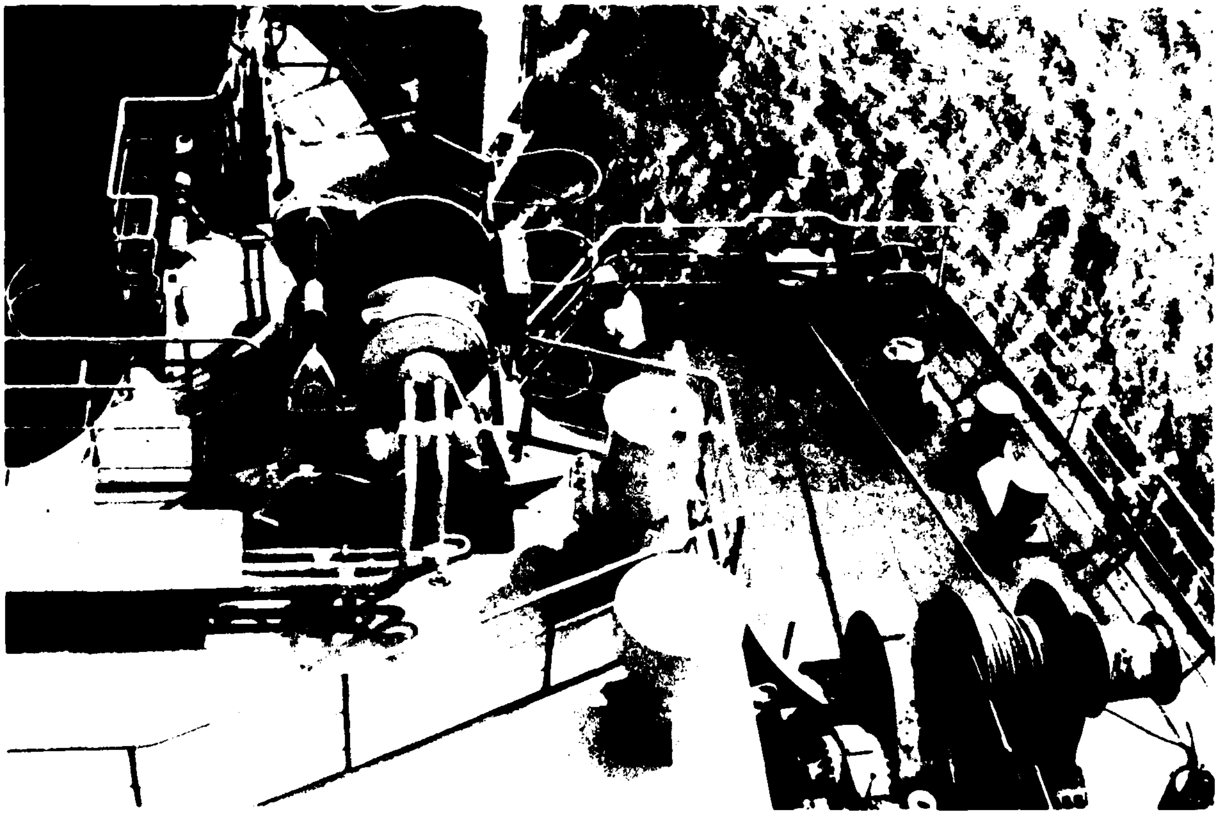


Figure 16 - MV CYGNUS's Aft Mooring Line and Winch

During night operations the four wire rope mooring pendants were removed from the ship's external padeyes using the inflatable dinghy and the two ships' mooring lines were removed.

Test Conclusions.

1. The CPF can be adequately positioned and moored in a stand-off arrangement provided the following conditions are met:

a. The CPF has two attending boats/tugs to keep the platform in position to the wind, current, and sea conditions at that time (see Test Objective 2).

b. The subject ship has the necessary mooring lines and winches for securing the trailing CPF to the ship.

c. The ship has the necessary external mooring attachment padeyes (such as the propeller handling padeyes located near the waterline at the stern of the MV CYGNUS). These padeyes normally exist on all merchant ships.

2. The use of a hard bottom, inflatable dinghy with an outboard motor to attach the mooring pendants to the ship's padeyes is a simple, effective procedure for self-sustaining RO/ROs.

3. The mooring pendant thimble plates have been redesigned following the test, to prevent laying on their side against the padeyes.

4. When rough sea operations are anticipated longer mooring pendants should be installed on the ship's mooring padeyes and secured to the ship's mooring bitts for ocean transit. The preinstalled mooring pendants could be easily passed to the CPF from the ship via messenger lines thereby eliminating the need to use the inflatable dinghy in rough seas.

5. A simple fendering system design has been added to the ship end of the CPF to eliminate the possibility of damage to the ship and/or CPF during mooring. This design was completed following the test.

6. A portable light (i.e., battle lantern) should be carried in the dinghy for use during mooring pendant installation and removal at night.

Test Objective 2

To confirm the number of warping tugs/tender boats required to assemble, transport, position, and maintain the CPF in the "stand-off" mooring.

Test Results. Two warping tugs were utilized successfully to assemble, transport, and initially position the CPF astern of the ship prior to the lowering of the ramp. During all five days of the exercise, environmental conditions (Sea State 0-1) were such that no additional craft were required (see Figure 17).

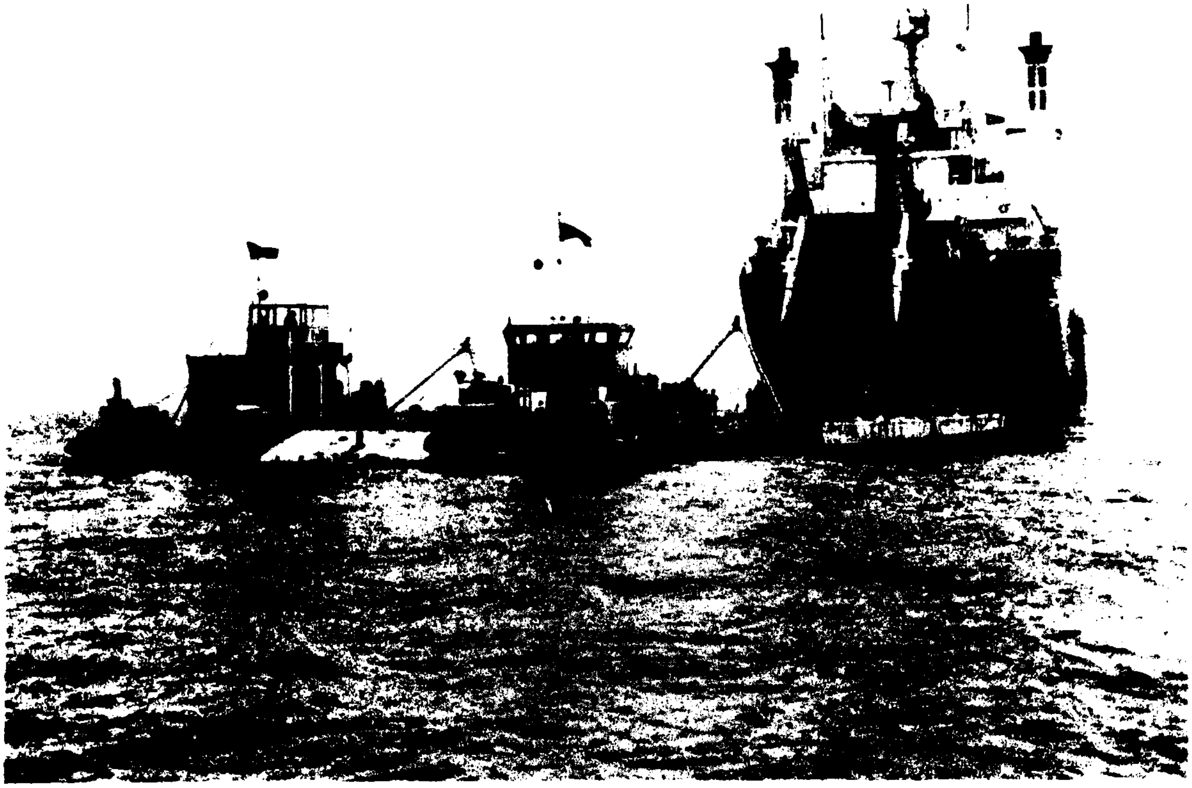


Figure 17 - Positioning of CPF with Two Warping Tugs

Once the ship's ramp was lowered into place on the CPF, no CPF warping tugs were found to be needed to maintain the position of the CPF with respect to the ship's stern except as described below.

The use of a warping tug to provide lateral alignment of a Causeway Ferry during the marriage to the CPF resulted in some rotation of the CPF about the ship's ramp (see Figure 18). After the marriage was completed the same warping tug was used to straighten the CPF by pushing in the opposite direction.

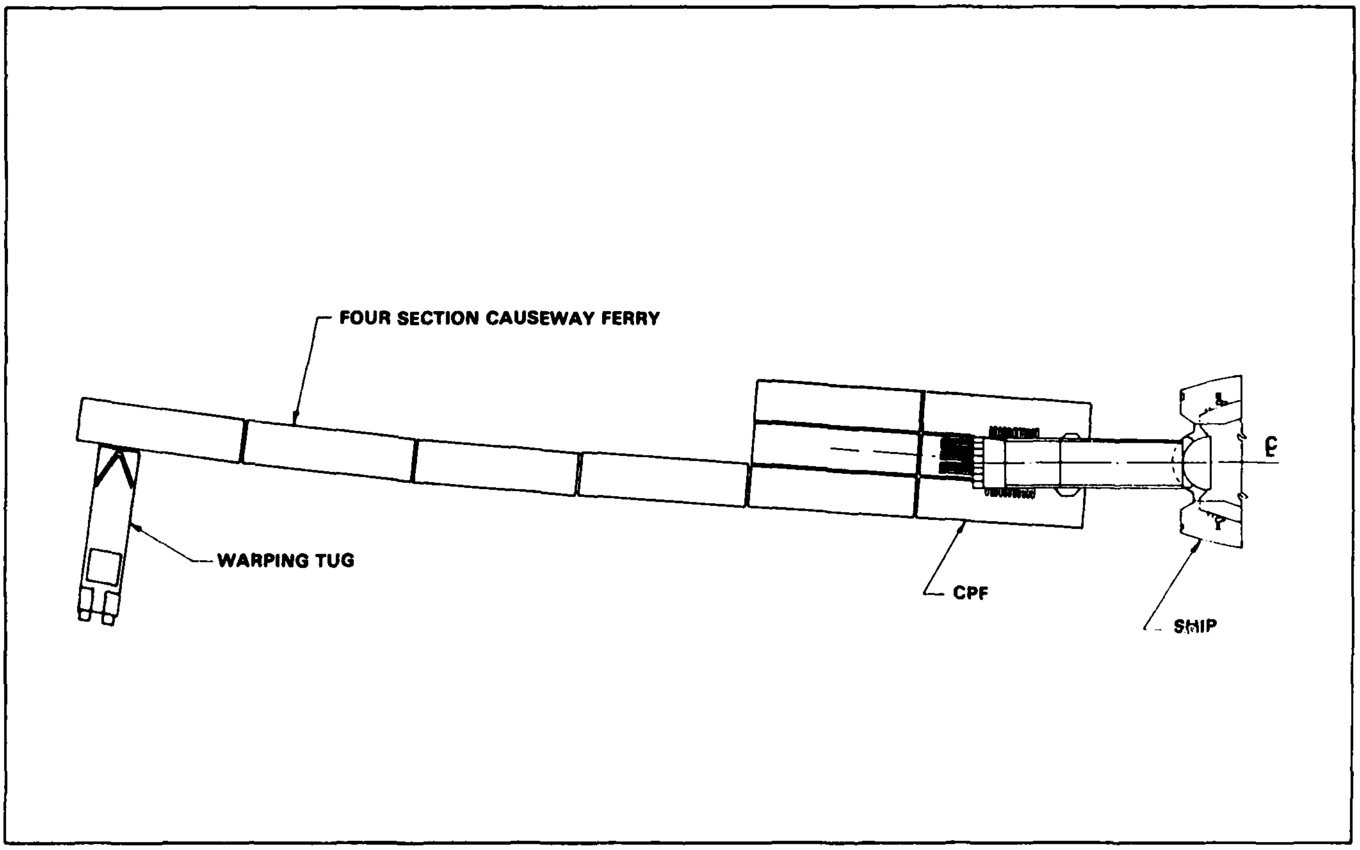



Figure 18 - Rotation of CPF caused by Warping Tug

Test Conclusion. Two warping tugs can satisfactorily assemble, tranport, position, and maintain the CPF in the astern mooring position. Once the ship's ramp is lowered onto the CPF the warping tugs can be used to assist Causeway Ferries in making marriages. The required number of new Side-Loadable Warping Tugs (SLWT) or Powered Causeway Sections (PCS) would also be two.

Test Objective 3

Determine the suitability of the ramp hydraulic station protection gear.

Test Results. The initial installation of the gear during the first day of use proved to be awkward and time consuming. Before satisfactory installation could be achieved, partial disassembly of the gear was required followed by several trial and error attempts.

Because of the size and configuration of the hydraulic gear and winches on the ramp there is some personnel hazard during installation and removal of the cradle. In order to position the cradle under the ramp's lifting cables, the cross braces had to be removed from the cradle structure and the cradle lifted into place on the top flange of the ramp's main beams. From this point the cradle was pushed under the cables providing a form of cage around the hydraulic piping and winch. Once in place the cross braces were installed. The entire procedure requires personnel to be standing on the top flanges of the ramp's main beams with minimal available footing and awkwardly manuevering the cradles into place (see Figure 19). If a person lost his footing he would fall approximately 9 ft to the CPF below.

Removal of the cradles required the above procedure in reverse and was similarly awkward and hazardous.

Once properly installed, however, the cradles adequately protected the hydraulic piping from coming in contact with the ramp's lifting cables (see Figure 20).

Test Conclusions.

1. The hydraulic station protection gear will satisfactorily keep the ramp's lifting cables from coming in contact with the hydraulic piping.

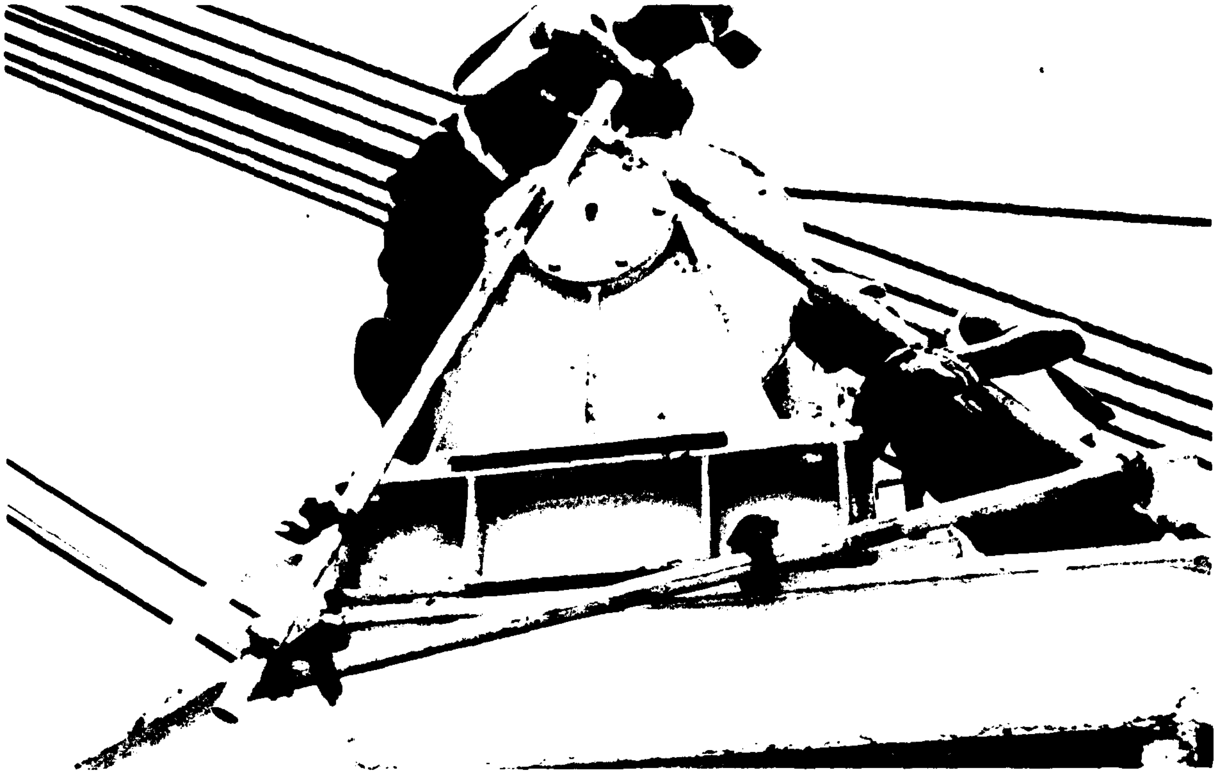


Figure 19 - Installation of Ramp Hydraulic Station Protection Gear

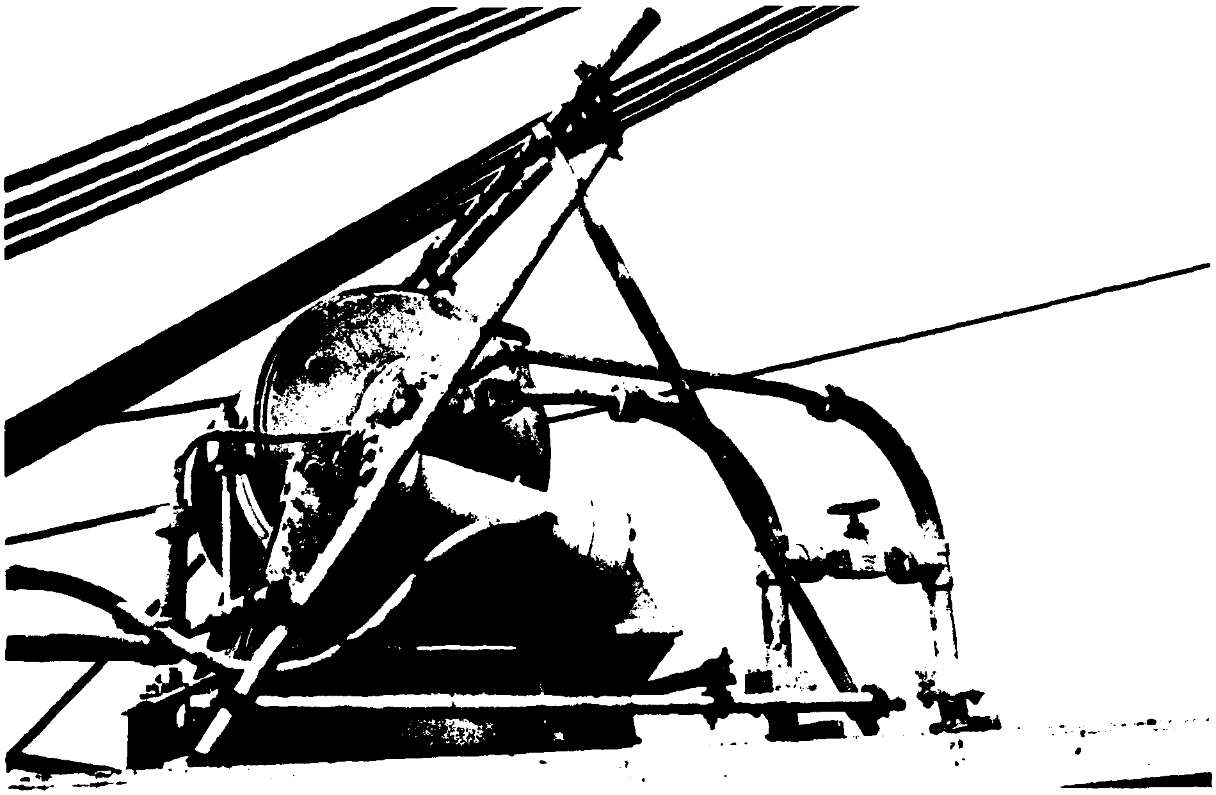


Figure 20 - Hydraulic Station Protection Gear

2. Installation and removal of the gear will be accomplished faster and easier by using the cradle redesigned following the test to incorporate the following design changes.

a. A pre-installation configuration without crossbraces.

b. Use of lighter weight pipe material.

c. Pipe lengths increased.

3. In order to minimize the hazard to personnel, safety harnesses will be provided for personnel to wear.

Test Objective 4

Evaluate the deck closure plates.

Test Results. Both configurations of closure plates were easily installed over most of the length of the 13-14 in. longitudinal gap between the causeway sections. Neither configuration, however, could be used to bridge the gap in the area of the end flexors in the middle of the CPF (see Figure 21).

The closure plates withstood the weight of both tracked and wheeled vehicles without bending.

In many locations along the gap the closure plates did not lay flat on the CPF assembly angles. As a result, when both tracked and wheeled vehicles transitted the closure plates the possibility presented itself for the closure plates to ride up on edge and fall through the gap. Several of the closure plates were lost in this manner. In order to prevent further loss, the closure plates were tied together with pieces of rope as shown in Figures 22 and 23. The configuration of the rope in Figure 23 proved to be the preferred method because it minimized damage to the rope by the vehicles transitting the plates.

Test Conclusions.

1. The overall closure plate concept worked well in providing a safe and efficient method for vehicles to transit the longitudinal gaps in the CPF. The plates also reduced the number of locations on the CPF where injury to personnel could occur due to stepping into uncovered gaps in the CPF deck, particularly at night.

2. The following additions and changes have been incorporated into the design of the closure plates:

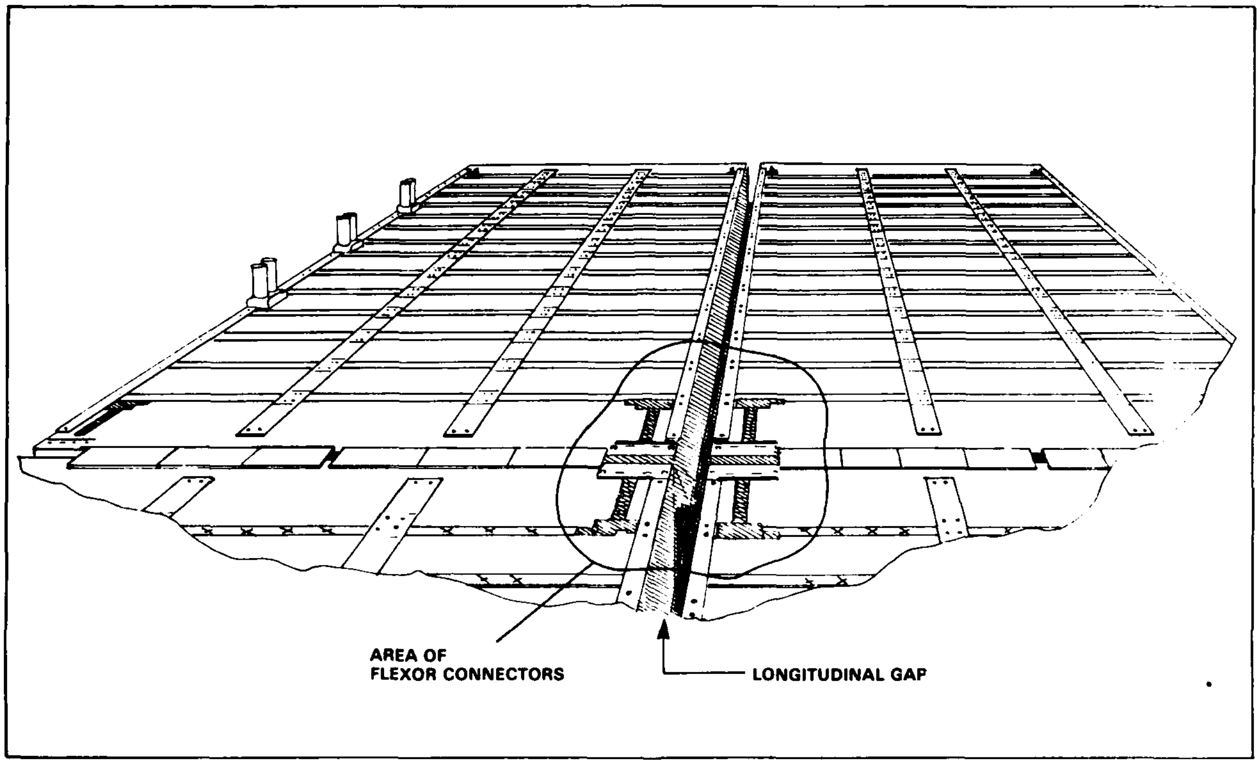



Figure 21 - Longitudinal Gaps in CPF

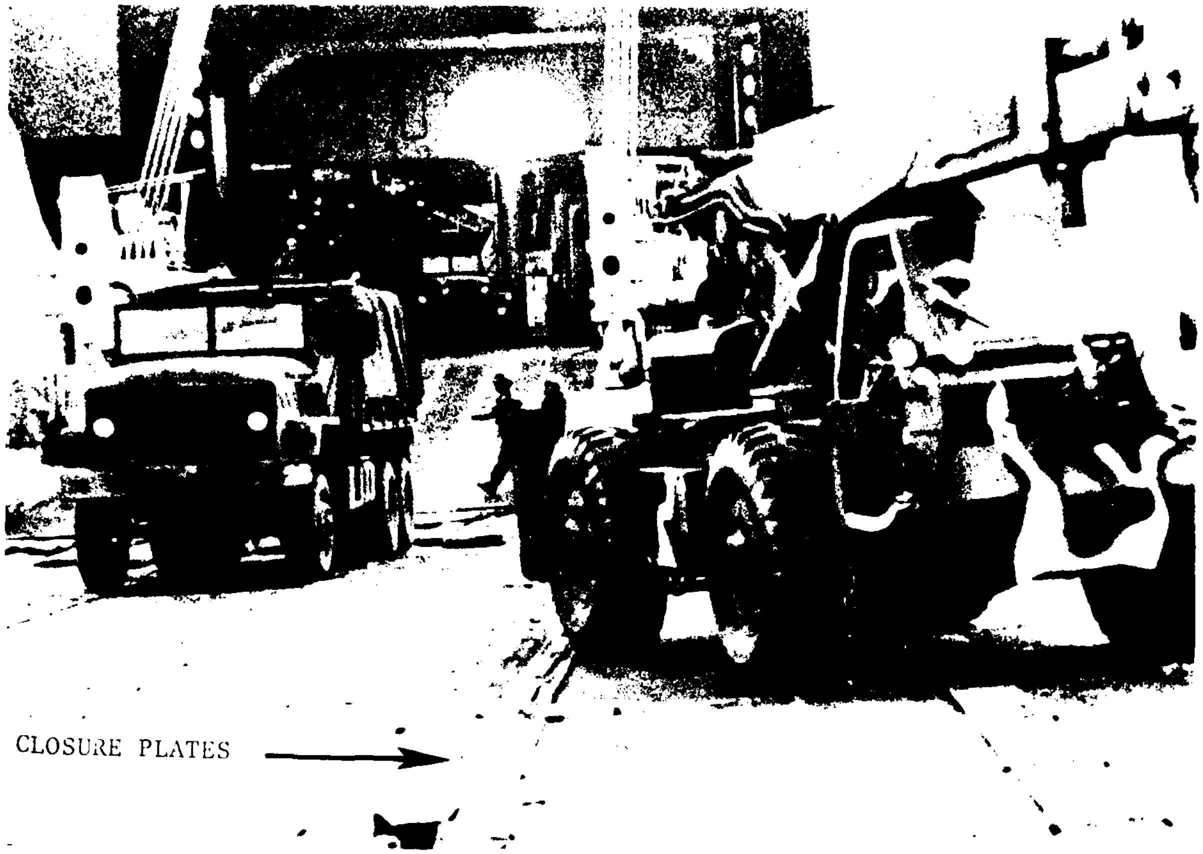



Figure 22 - Closure Plates

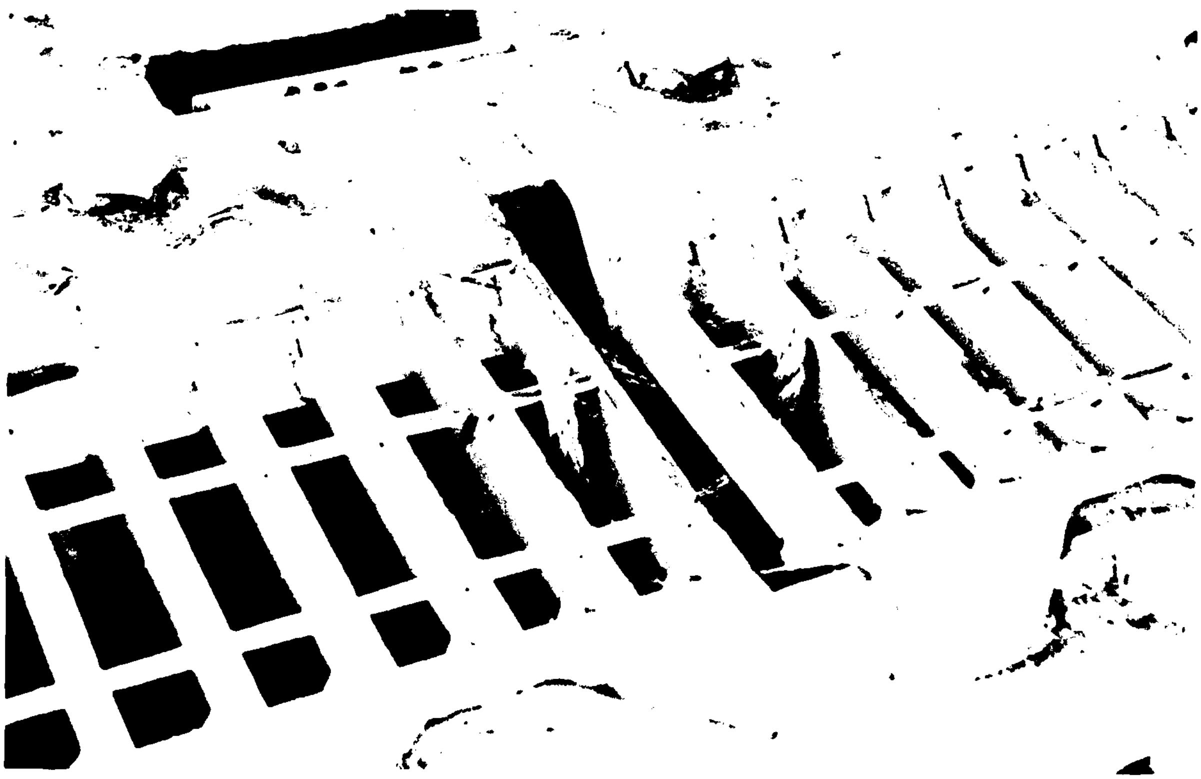


Figure 23 - Preferred Method of Securing Closure Plates

a. Two additional plate designs for covering the gap in the area of the end flexor connectors located in the middle of the CPF.

b. Holes added to the end bearing bars of each closure plate so that the plates can be tied together with rope and knot below grating surface.

Test Objective 5

Evaluate the procedures set forth in the system preliminary technical manual[6] and other system support documentation.

Test Results and Conclusions. The technical manual was found to be satisfactory overall in providing support information for the Discharge Facility. The test, however, pointed out that some subjects within the manual required a more detailed discussion and that additional subjects currently not discussed should be included in the manual.

This increased need for more detailed discussions of equipment and procedures is brought about in part by the continuing turnover in personnel familiar with the operation of the facility. The final technical manual, therefore, should provide sufficient information to support the operation regardless of the personnel experience factor. It should be noted that some of the changes deal with standard operations procedures that are documented in other publications. These should be included to highlight and emphasize their importance. The discussions that follow address those areas that are being modified in the final version of the technical manual.

Assembly Procedures.

1. Provide an overall CPF arrangement diagram that includes accessories.

2. Point out the use of lines to prevent loss of flexor replacement.

3. Describe the procedure and provide sketches for flexor replacement.

4. Indicate the requirement for spare flexors (6) in ship end of CPF.

5. Provide a general discussion and the installation procedure for a simple platform fendering system.

6. Provide a general discussion and the installation procedure for

deck closure plates. Incorporate a sketch showing the location of the plate types on the CPF and a method of tying them together with rope.

7. Indicate the necessity of lashing down all accessories.

8. Provide an assembly check list summarizing the assembly procedures.

Installation and Mooring Procedures.

1. Describe the mooring installation procedure. The use of a dinghy with outboard, maintaining minimum standoff distance and boat arrangement should be included in the procedure.

2. Describe the mooring removal procedures (passing lines to ship).

3. Describe the mooring reinstallation procedures (passing lines to the CPF from ship.)

4. Describe the mooring final removal procedures using a dinghy.

5. Describe the mooring procedure for rough seas when the mooring pendants have been pre-installed on the ship.

6. Point out the use of the Side Loadable Warping Tug (SLWT) or Causeway Section, Powered (CSP) to maintain platform orientation once the ship's ramp is in place.

7. Describe the procedure and provide sketches for the installation of the ramp hydraulic station protection gear. Include pre-installation configuration and the use of the safety harnesses.

8. Emphasize the necessity for periodic platform inspection/maintenance (i.e., dunnage, closure plates, and equipment lashings).

9. Provide an installation and mooring procedure check list.

Lighting Equipment Description and Operation.

1. Provide a sketch showing the arrangement of two light plants and portable lights.

2. Provide a description and a sketch of the range/alignment lighting for use during Causeway Ferry marriages at night.

3. Indicate the requirement for and the location of navigation lights for the CPF.

Other CPF Necessary Information.

1. Describe in detail the platform disassembly procedure emphasizing the importance of keeping the causeway sections tied together until flexors have been removed.

2. Describe the procedure and provide sketches for the anchoring of the platform.

3. Provide a list of all accessories (SEABEE shed, light plant, tools, light wands, T-bitts, spare guillotines, rope, chain saw, etc.).

Use of Causeway Ferries with the CPF.

1. Point out the necessity of leveling the outboard sections of the platform prior to the marriage using support vehicles (i.e., tank retriever, wrecker, etc.). Include sketches for guidance.

2. Call attention to the fact that prestaging of vehicles on the CPF prior to completion of the marriage increases misalignment between the CPF and Causeway Ferry.

3. Provide a discussion of the Causeway Ferry approach and departure procedures to and from the CPF. Include minimizing standoff distances, low speed approaches to the CPF, the use of one of the CPF warping tugs to aid in the marriage and clearing approach lanes upon departure as quickly as possible.

4. Describe the marriage procedure and include the following points.

a. Flexor Installation - show use of retaining cables.

b. The use of a bridle for rough weather marriages.

c. Guillotine binding during installation or removal occurs when the Causeway Ferry is misaligned laterally. Provide a sketch showing how to correct the problem (installation of one flexor at a time using the pivoting procedure).

d. The use of portable bitts on the B section if present.

e. Point out necessity of allowing for draft adjustments of Causeway Ferry sections during marriage by proper load placement during back loading.

f. Tender boats, warping tugs and powered causeway sections should maintain power ahead during removal of flexors when divorcing from the CPF.

5. Provide a preferred loading procedure that includes such safety considerations as the placement of one heavy vehicle per causeway section, no heavy vehicles at extreme ends and single file loading of vehicles during rough seas operations.

Use of LCUs with the CPF.

1. In order to decrease transit time to the CPF and expedite the marriage with the B section, a minimum standoff distance from the CPF should be maintained by the LCU.

2. Once the marriage is complete, the LCU bow ramp chains should be slacked by hand before loading or offloadings begins.

3. LCU operations can be carried out simultaneously with CPF operations.

4. Unlike Causeway Ferry operations, vehicles can be staged on the CPF.

5. Vehicles that do not lend themselves well to backing should be handled by the Causeway Ferries.

6. Having completed loading or unloading, the LCU should clear the approach lanes to the marriage location as quickly as possible.

Vehicle Movement.

1. Only one vehicle at a time should transit the ship's ramp during operations and at no time should a vehicle be parked on the ramp.

2. Vehicle directors should be stationed at the head of the ship's ramp, at the foot of the ramp, at the end of the CPF and at about 150 ft apart on the Causeway Ferry. This system of prepositioned directors should keep vehicular movement and control continuous from the ship to the lighter.

3. During those loading operations where vehicles are backing, the vehicle should be accompanied by a director at the front and rear of each vehicle.

4. Use standard hand and light wand signals for all vehicle drivers and directors.

5. Extra care should be taken by the driver and directors of tracked vehicles to minimize damage to the ship, the ramp, and CPF.

6. The brakes on all vehicles should be tested before the vehicle drives down the ramp. A wrecker or other suitable vehicle should be available to move vehicles with defective/questionable brakes.

Additional Safety Considerations

1. Life rings and lines should be positioned at the lighterage loading end of the CPF on both port and starboard sides.

2. At least one craft (SLWT or CSP) or the dinghy should be readily available to assist in case of overboard personnel.

3. All platform gaps on the CPF should be covered and maintained.

Test Objective 6

Administrative Interest Item - Evaluate LCU/B section marriage procedures.

Test Results.

1. In order to evaluate the present capability of the LCU to be used with CPF a B section was connected to the CPF as shown in Figure 24.

2. The majority of the LCU/B section marriages were accomplished quickly with little or no difficulty. The exceptions to this trend were encountered during those periods of operation when the ship and platform were rotating about the mooring due to tide changes.

3. Two portable rhino horns were bent due to misalignment of the LCU bow ramp with the rhino horn during marriage attempts. In both cases the rhino horn was rammed by the LCU ramps that had been lowered too far (see Figures 25 and 26) prior to the LCU being in the correct position for marriage.

4. The high strength rhino horn shown in Figure 27 was found to have a tendency to become engaged in the swash holes in the LCU bow ramp during those marriage attempts where the ramp made contact with the rhino horn outside of the "V" notch on the underside of the ramp. This raised concern that damage could be done to the ramp and/or the rhino horn when further alignment was attempted.

5. On several occasions the ramp lifting chains were not slacked enough which created a dangerous situation during vehicle loading.

Test Conclusions.

1. The high strength rhino horn has been redesigned following that test with less taper and with a crown on top.

2. After completing the marriage between the bow ramp and rhino horn, the ramp lifting chains must be slacked manually before allowing vehicles to transit the ramp. There must be sufficient slack in the chain so that at least two chain links lay on the LCU's ramp.

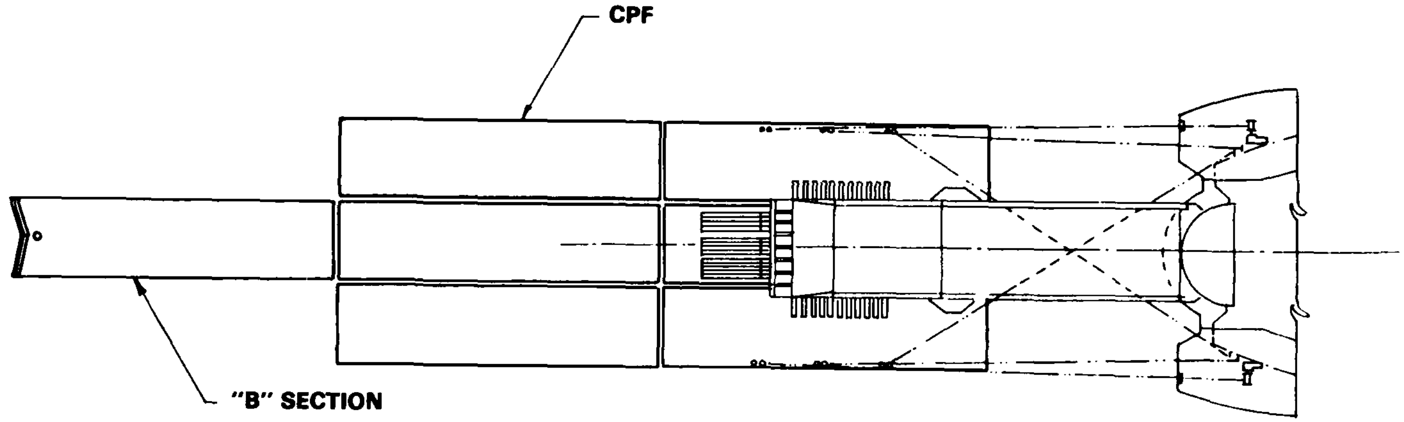



Figure 24 - CPF B Section Configuration

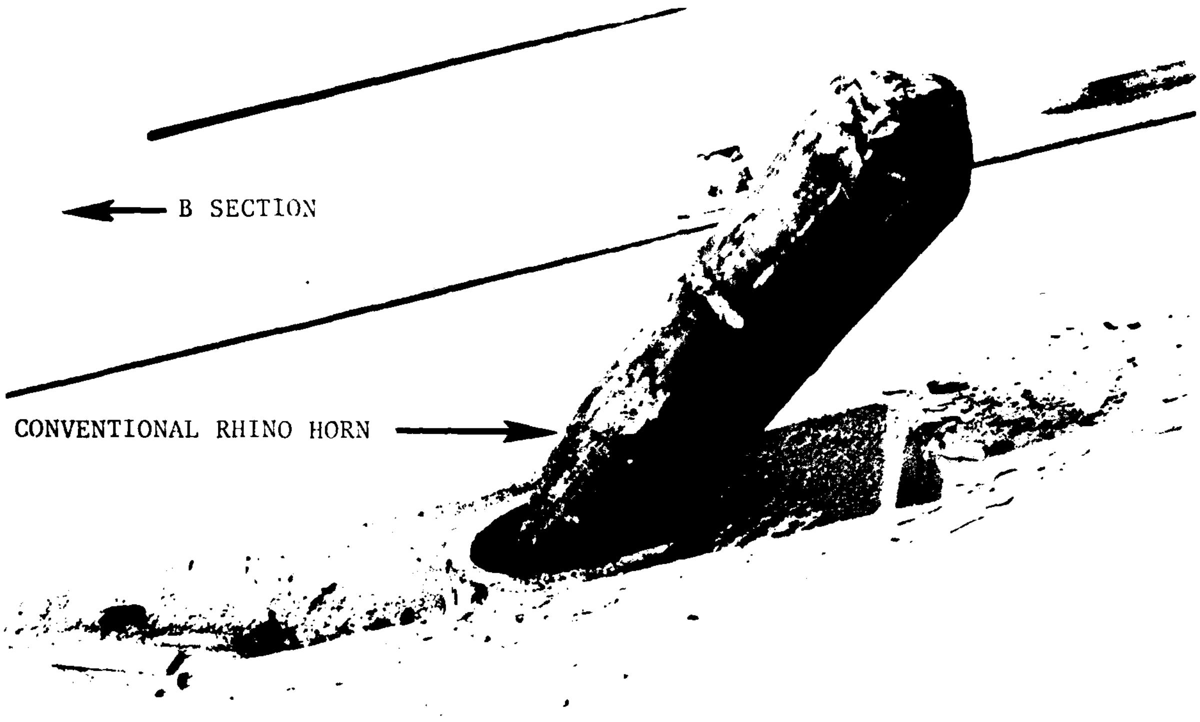



Figure 25 - Conventional Rhino Horn Damaged by LCU Bow Ramp

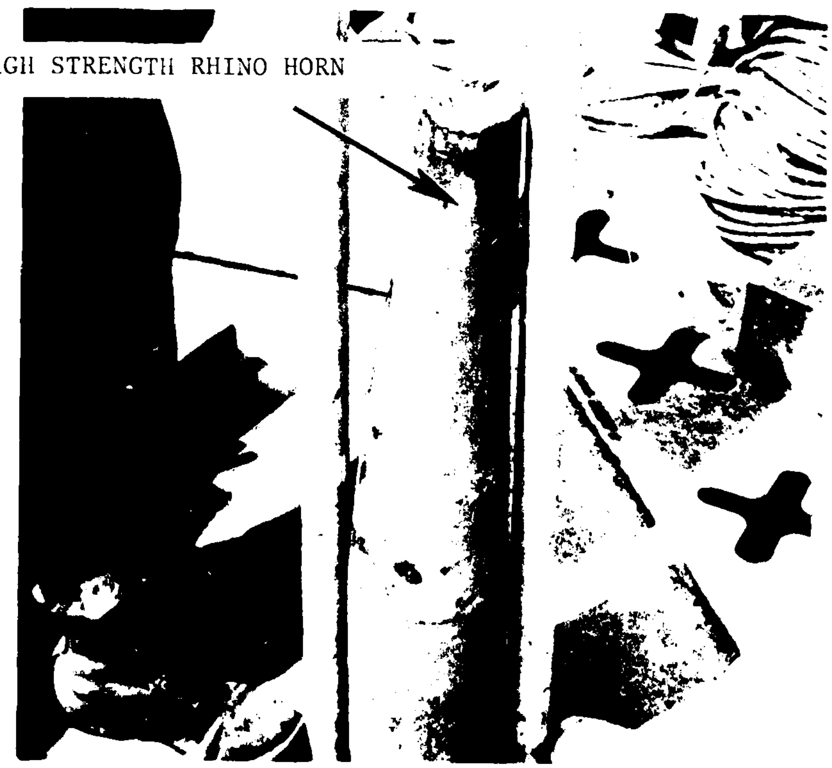



Figure 26 - Extent of Bending of High Strength Rhino Horn


Figure 27 - LCU Bow Marriage with B Section

SUMMARY OF SS ATLANTIC BEAR TEST RESULTS

Objective 1

To confirm that the Calm Water Ramp (CWR) and Causeway Platform Facility (CPF) assembly procedures are adequate.

Test Results. The test commenced with the Causeway Platform in two assemblies, a 2 x 2 section plus B section assembly and a 1 x 2 section assembly. The platform assembly was first attempted using methods not discussed in the technical manual. Specifically, a single part purchase vice a two part purchase from the warping tug's winch (see Figure 28) was used to bring the flexors in line vertically during side to side marriage. This resulted in a delay of 35 min. Once the proper methods were used, platform assembly proceeded quickly. Total time elapsed was approximately 1 hr, including the 35 min time delay. The ramp was assembled using methods developed previously and approved in the system technical manual (see Figure 29)[3,6]. Some difficulty was encountered in

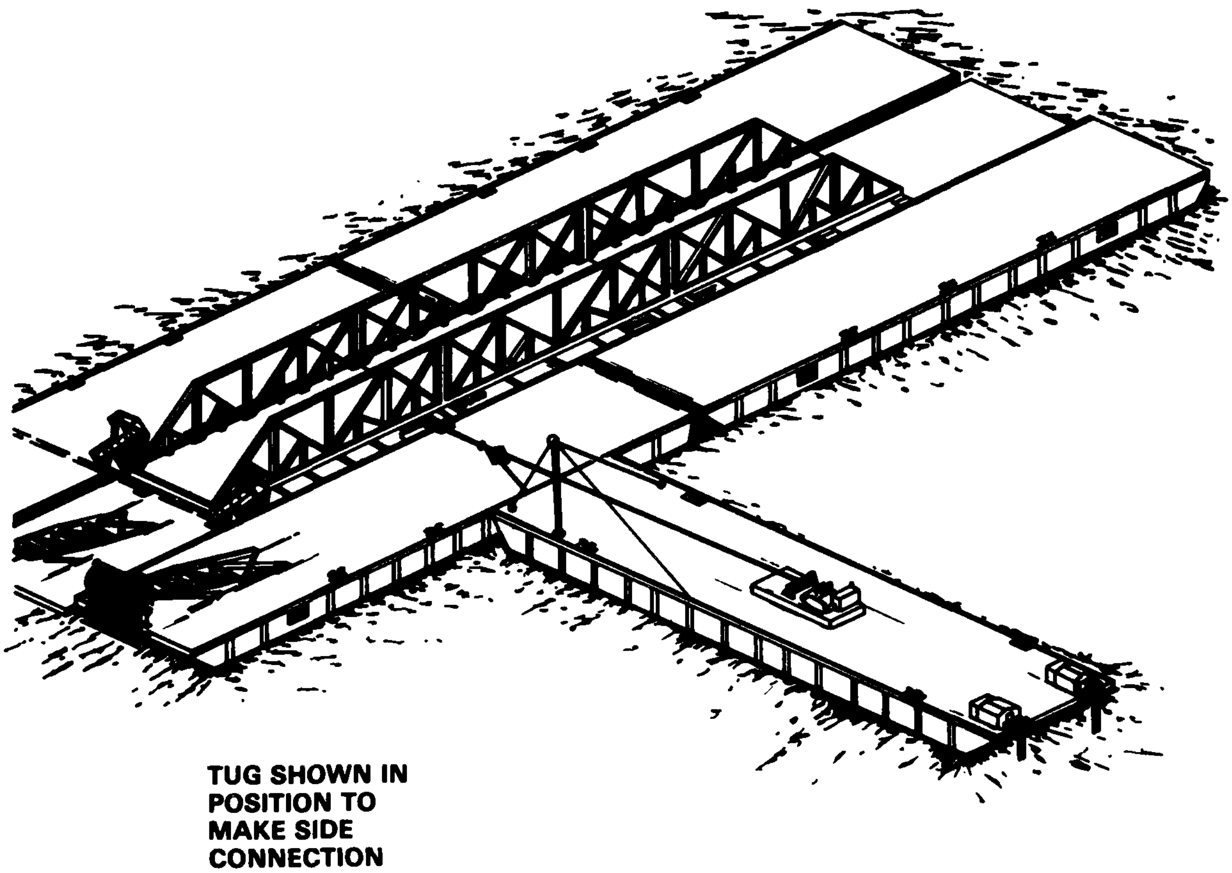



Figure 28 - CPF Assembly

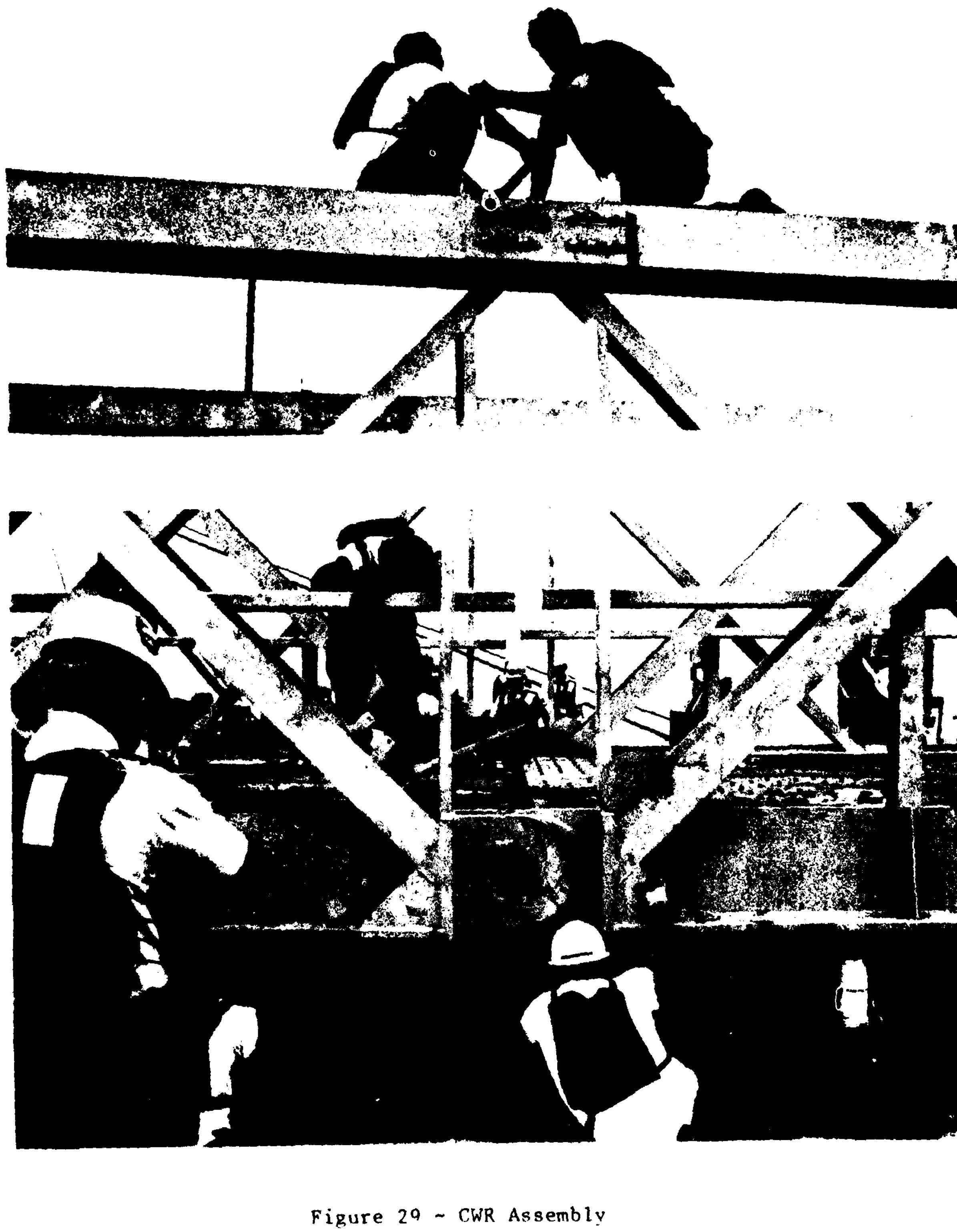


Figure 29 - CWR Assembly

the lowering of the assembled ramp from the blocking onto the ramp pads. The current method of incrementally lowering the ramp to lower blocking with portable hydraulic jacks is slow.

Fender assembly was accomplished using a 30 ton hydraulic crane which was brought to the CPF on a Causeway Ferry. Slight difficulties were encountered in aligning the assemblies with the foundations welded to the causeway platform (see Figure 30).

Test Conclusions. The Calm Water Ramp and Causeway Platform Facility assembly procedures are adequate.

The assembly procedures which have been revised will be enhanced by:

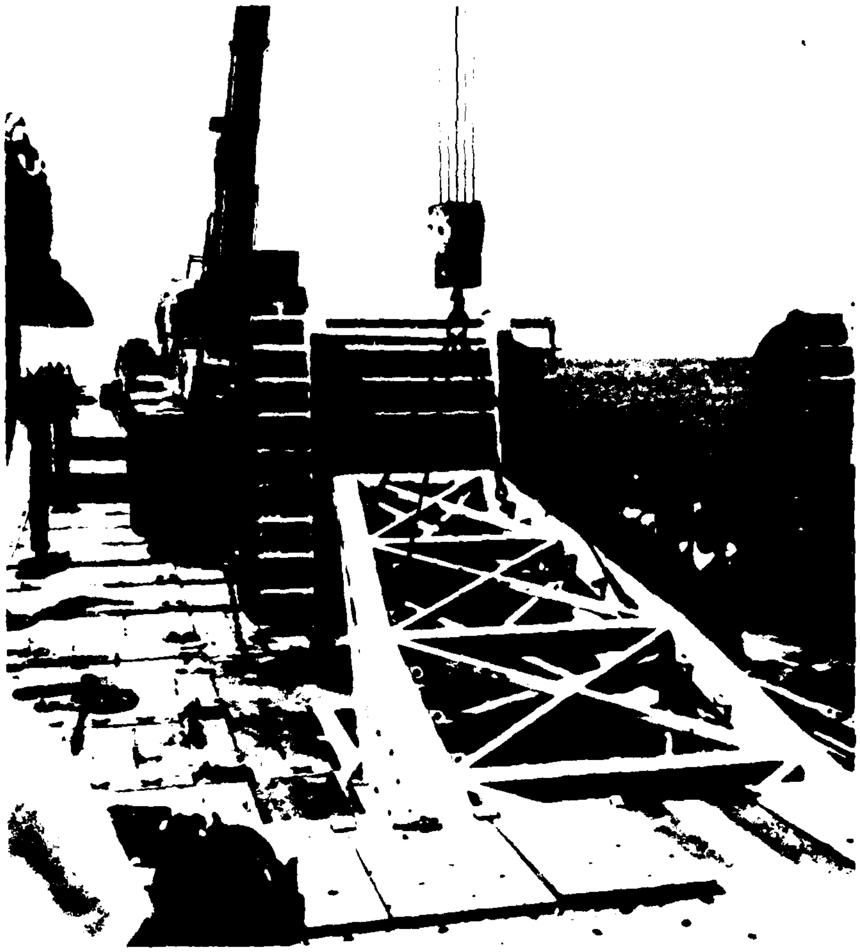
a. A simpler means of lowering the assembled CWR from its blocking.

b. A method to align each fender assembly with its CPF foundation as the DROTT crane lowers the fender assembly into place.

Objective 2

To establish the minimal number of resources (equipment, personnel, warping tugs/tender boats, etc.) required to assemble, transport, position, and moor the CPF at selected offloading ports (transom and/or side ports).

Test Results. Assembly of the platform occurred on 13 September. On 14 September the CPF left Little Creek and encountered heavy seas in the Bay enroute to the SS ATLANTIC BEAR. Several mooring lines between the warping tugs and the CPF parted, warping tug fenders were dislodged, the B section was damaged and one warping tug was damaged. All of the damage resulted from the relative motion between the tugs and the platform. Figure 31 shows the sea conditions and the damaged areas on the B section and the warping tug. It should be noted that both tugs were tied to the B section with only mooring lines. Mooring of the platform to the ship was attempted on 16 September. The platform was maneuvered by two warping tugs connected as shown in Figure 32 in Sea State 2-3 (wave height 2.5-4.0 ft) conditions. One warping tug connected to the CPF with flexors experienced no problems; the other tug tied in conventionally, broke mooring lines repeatedly. Once the CPF was alongside the SS ATLANTIC BEAR, one fender assembly was damaged due to the severe vertical motions (5 to 8 ft) and loads encountered against the ship. The upper fender support pipe contacted the ship's side and after repeated



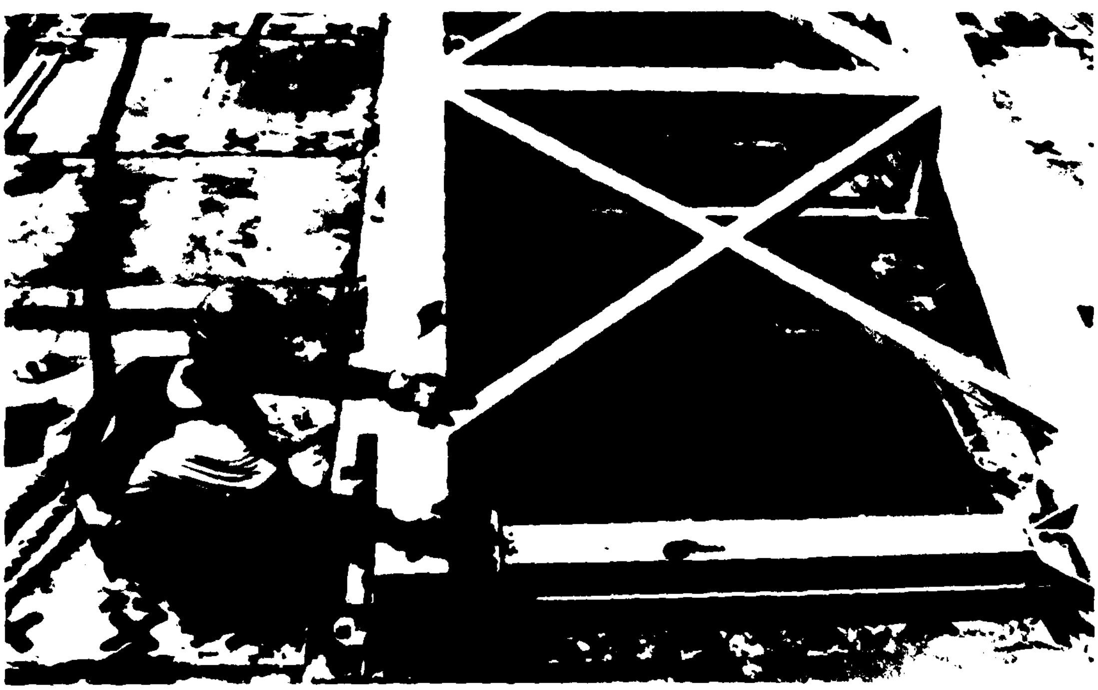


Figure 30 - Fender Assembly Installation

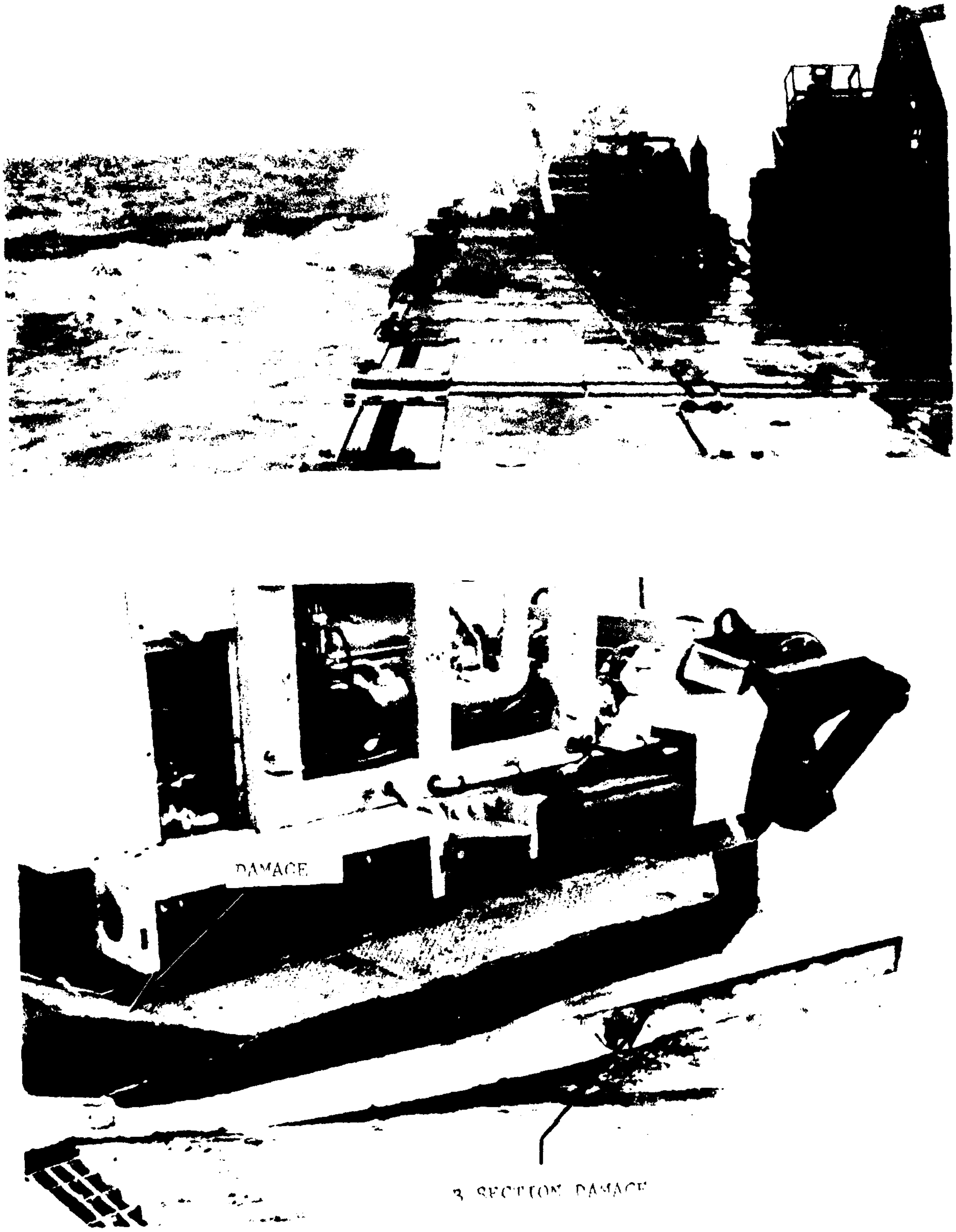



Figure 31 - CPF in Heavy Seas and Resulting Damage

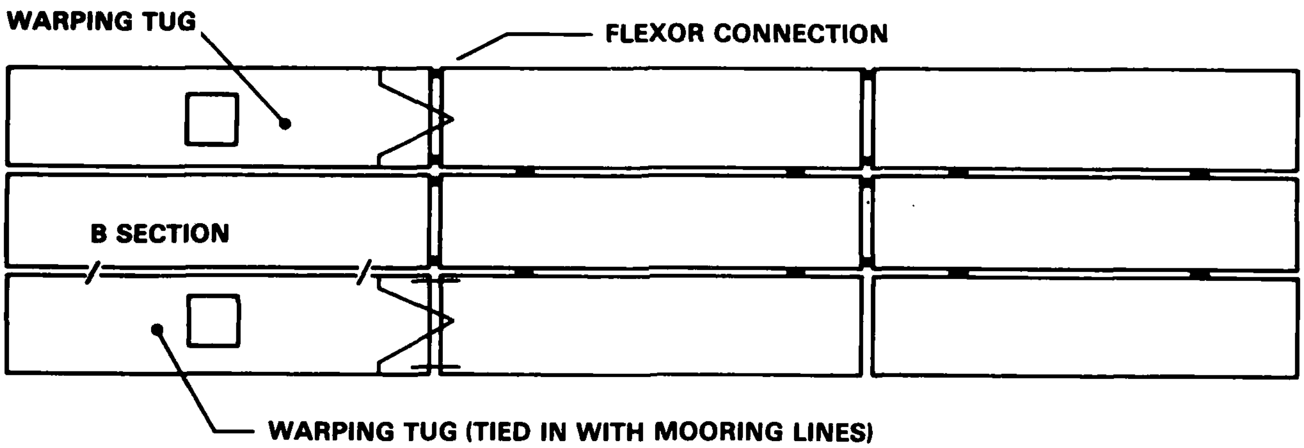
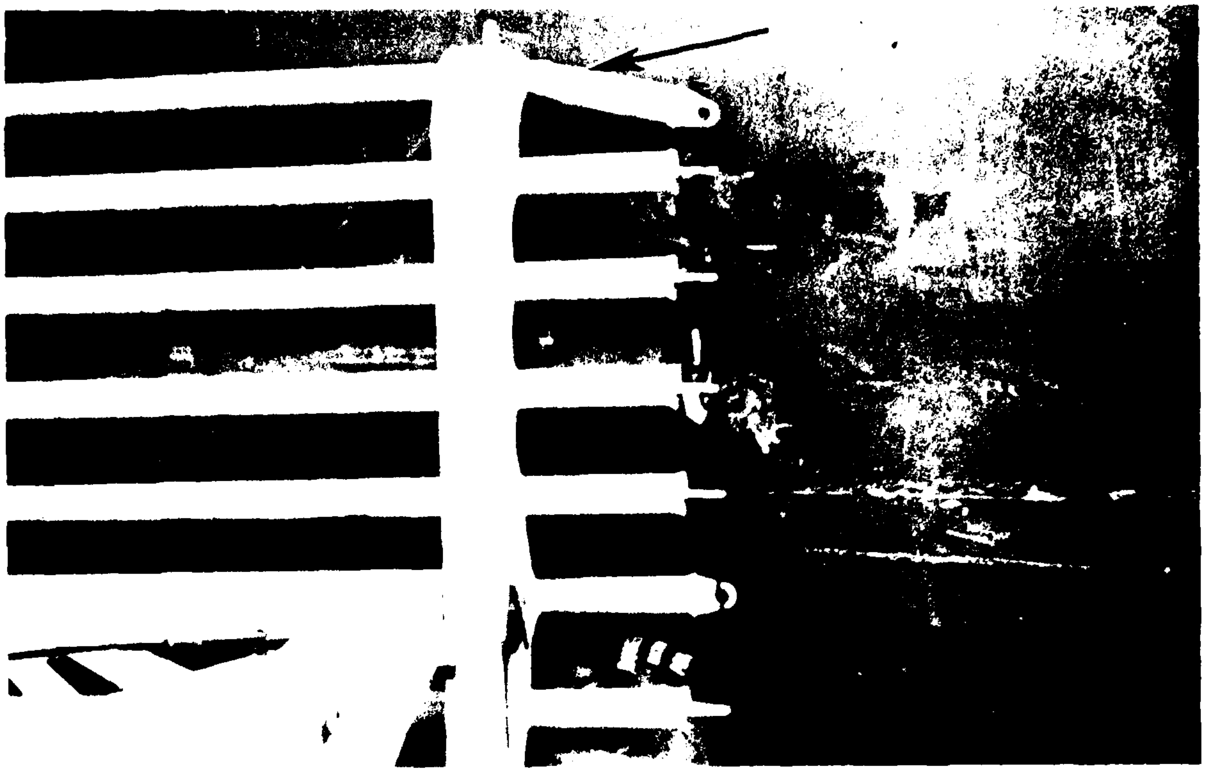



Figure 32 - CPF Enroute to SS ATLANTIC BEAR

contacts it was broken (see Figure 33). In addition it was felt that attaching the mooring lines to the recessed bollards along the ship was too dangerous because of the sea state. The CPF was moving from 5 ft to 8 ft vertically with respect to the side of the ship. Before the CPF was returned to Little Creek for fender repairs the CPF was positioned directly astern of the SS ATLANTIC BEAR at the transom ports. This was done in order to determine the sheltering effect the ship had on reducing the vertical motions of the CPF. The relative motion was much less at the transom location. The CPF vertical motion



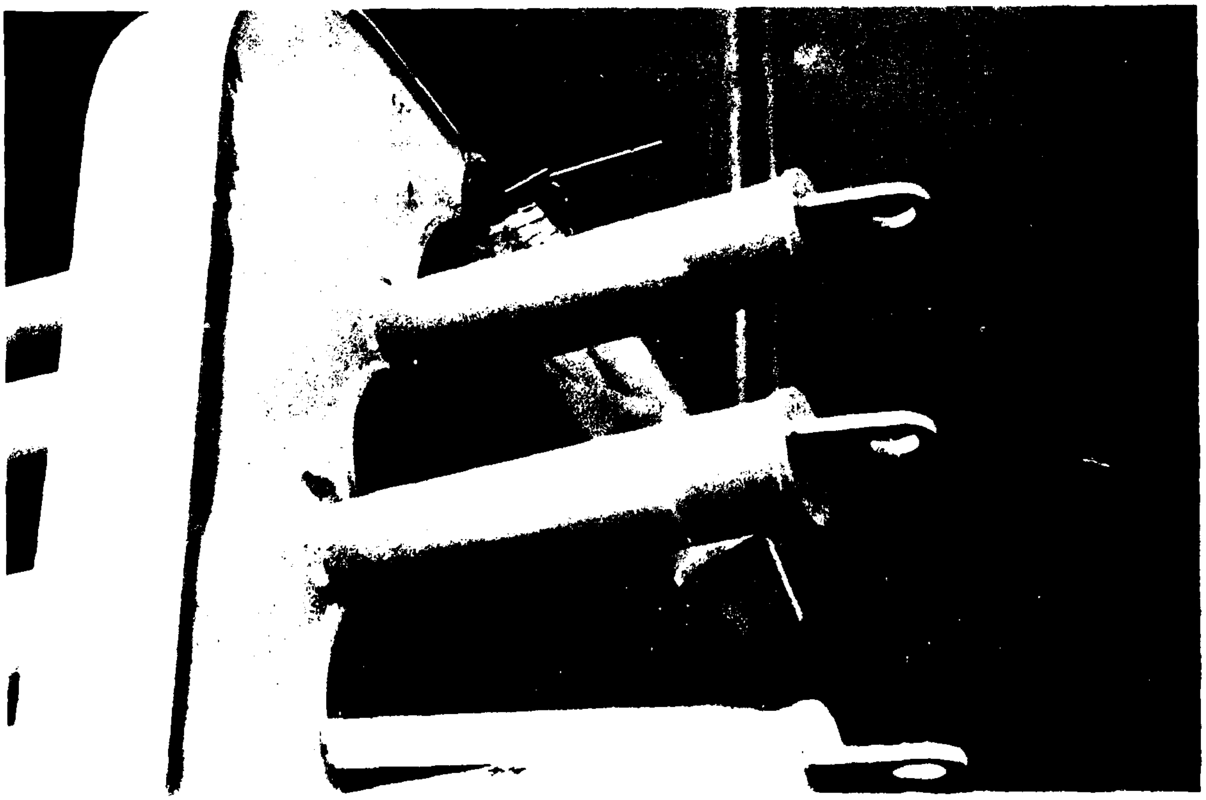


Figure 33 - Fender Damage

with respect to ships' transom varied from 3 ft to 4 ft. Figure 34 shows this transom port arrangement. This clearly shows that given a choice, the transom port should be used instead of a side port. However, six of the ten nonself-sustaining ships have only side ports. For those ships, the aft side port is the preferred side port because of shipboard vehicle movement restrictions at both the mid-ship side port and forward side port. The mooring was then cancelled for the day so that repairs could be made to the fenders. As shown in Figure 35 the fender assemblies were modified by attaching the fenders directly to the support frame and grease was applied to reduce friction forces. Successful mooring operations were carried out on 17 and 20 September. The approved mooring procedure and arrangement is shown in Figure 36.

Some difficulty was encountered in installing the mooring lines on the ship's recessed bollards when using an LCM-6 tender boat to pass the lines to the bollards from the causeway platform (Figure 37). The LCM-6 became tangled in one of the installed lines and two sailors were slightly injured (bruised back and fingers) in freeing the line. Additionally, it was difficult to achieve a reasonable tension on the lines without mooring winches. The lines were tightened somewhat using a warping tug winch. The ship's forward mooring winches were not operational.

The purchase angle of the lines leading aft did not permit them to be very effective. Additionally, the ATLANTIC BEAR's aft mooring cables were in poor condition so that the constant tension winches were not used (One wire cable parted early in the test and was replaced by a synthetic line, manually tightened).

Test Conclusions.

1. The CPF can be moored safely at a side port in Sea State 0-1 with the personnel designated in the system technical manual and two warping tugs (CSP/SLWT).

2. The assembly, transportation, positioning, and mooring of the CPF will be enhanced by:

a. Using warping tugs married to the CPF with flexors vice mooring lines.

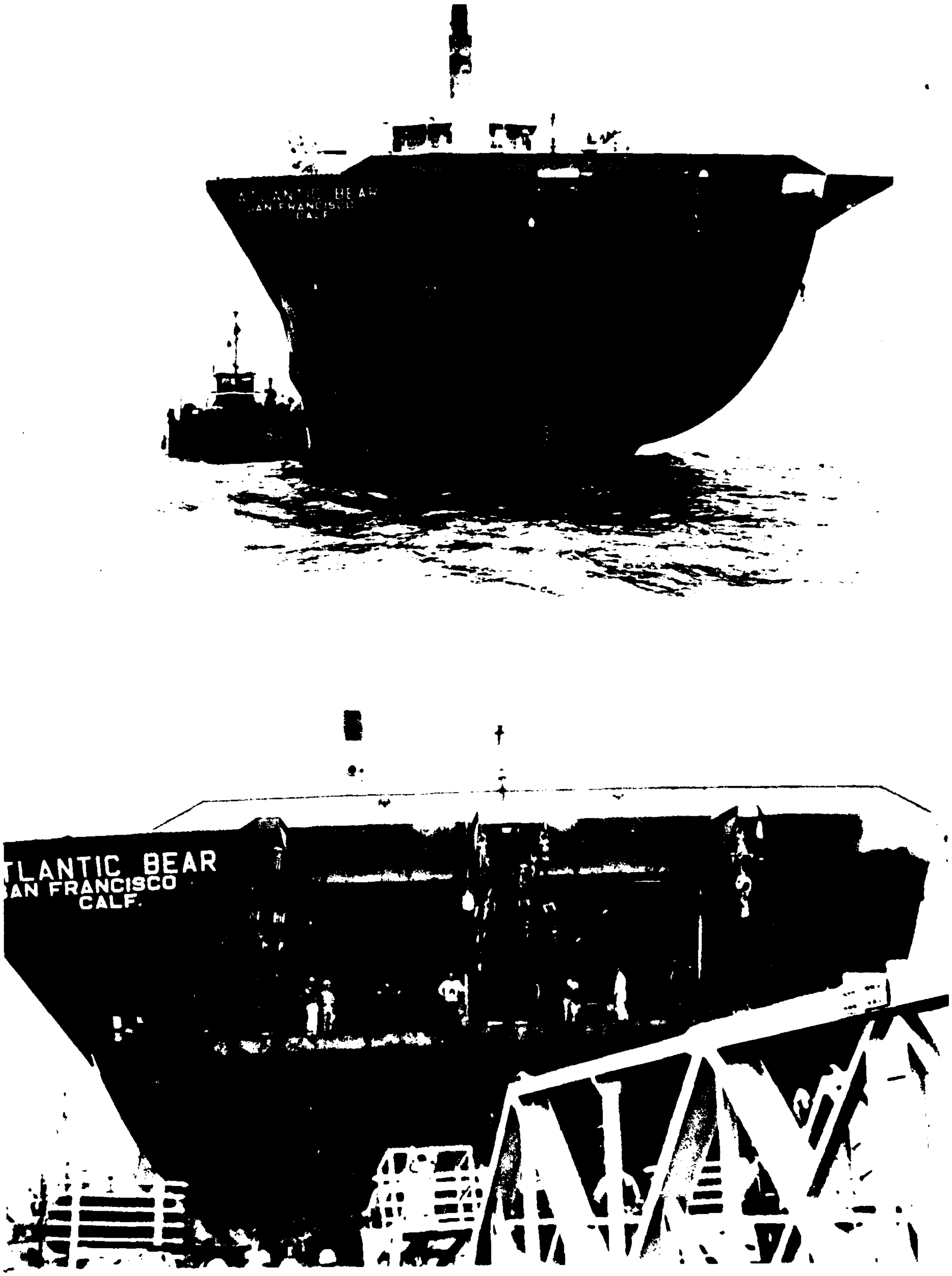
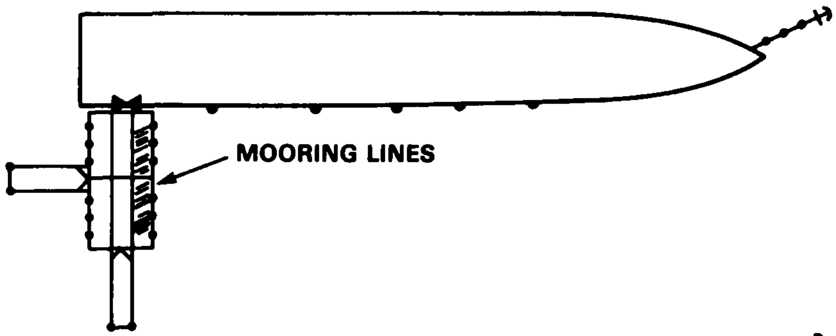


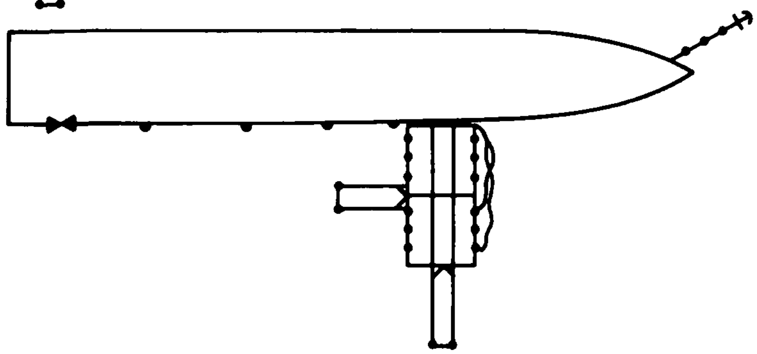

Figure 34 - CPF at Transom Port of SS ATLANTIC BEAR

Figure 35 - Repaired Fenders

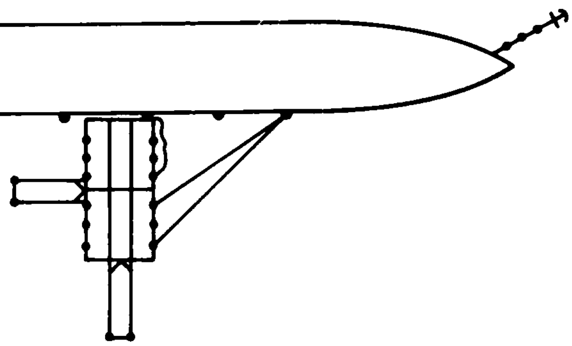
1. SHIP ANCHORED (PORT ANCHOR)
   CPF IS POSITIONED BENEATH PORT
   MOORING LINES ARE PASSED TO CPF




2. CPF MOVED FORWARD BY WARPING TUGS
   TWO LINES ARE PASSED TO SHIP'S BITT
   FROM CPF'S BOLLARDS



3. CPF IS MOVED AFT, KEEPING TENSION
   ON MOORING LINES.
   REMAINING TWO LINES ARE CONNECTED
   TO SHIP'S RECESSED BOLLARDS AS
   SHOWN



4. CPF IS MOVED AFT TO OFFLOADING PORT
   TWO LINES ARE PASSED TO CPF FROM
   SHIP AS SHOWN AND TIGHTENED WITH
   WINCH
   REMAINING LINES ARE TIGHTENED
   WITH WARPING TUG WINCH AS
   REQUIRED

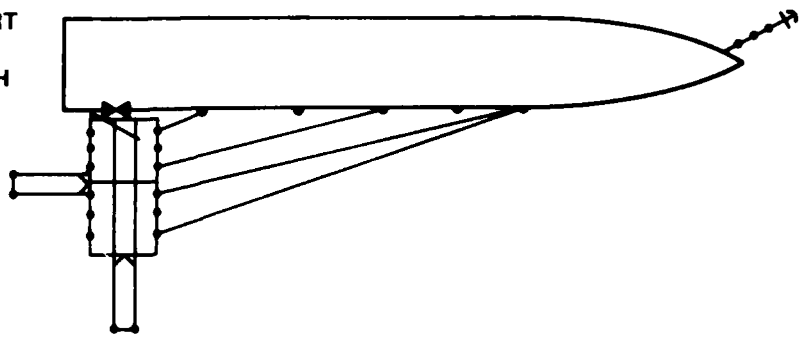


Figure 36 - CPF Mooring Procedure to SS ATLANTIC BEAR's Aft Side Port

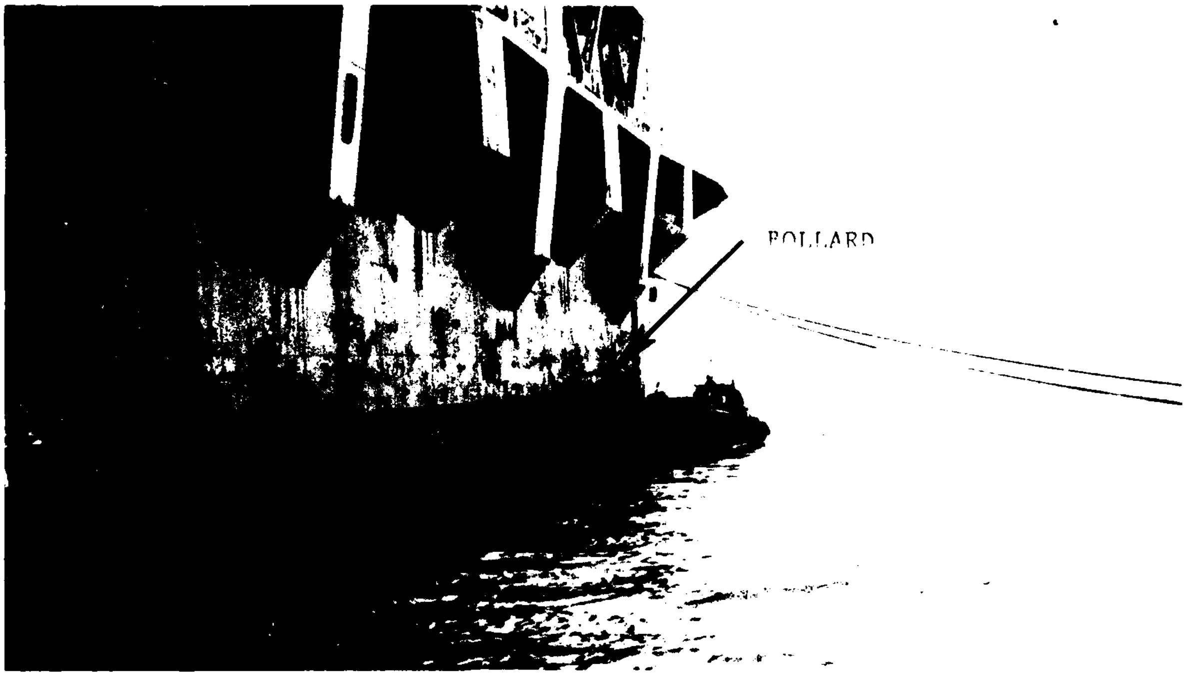



Figure 37 - Landing Craft Mechanized (LCM-6)

b. Using the fender assemblies which have been redesigned to eliminate the problems encountered.

c. Installing 3 mooring line pendants at the recessed bollards alongside the ship before ocean transit. These pendants would be secured tightly on the bollards and run to the ship's mooring bitts by the ship's force. Once on station the ship would lower the pendants. Platform personnel could then grasp the pendants from the platform deck by using a boat hook. This would eliminate the need for someone to climb on top of the fender assemblies (Figure 38) and should enable the mooring to be done in Sea State 2 conditions.

d. Using the ship's fore and aft constant tension mooring winches and mooring capstans to tighten the forward two mooring lines and the aft two mooring lines. This will help position the platform and maintain its alignment at the side port.

e. Using the improved mooring procedure as described in the final technical manual.

Objective 3

To determine the suitability of raising the CWR up to the ship's offloading ports and securing it to the ship using ship's existing ramp handling winches.

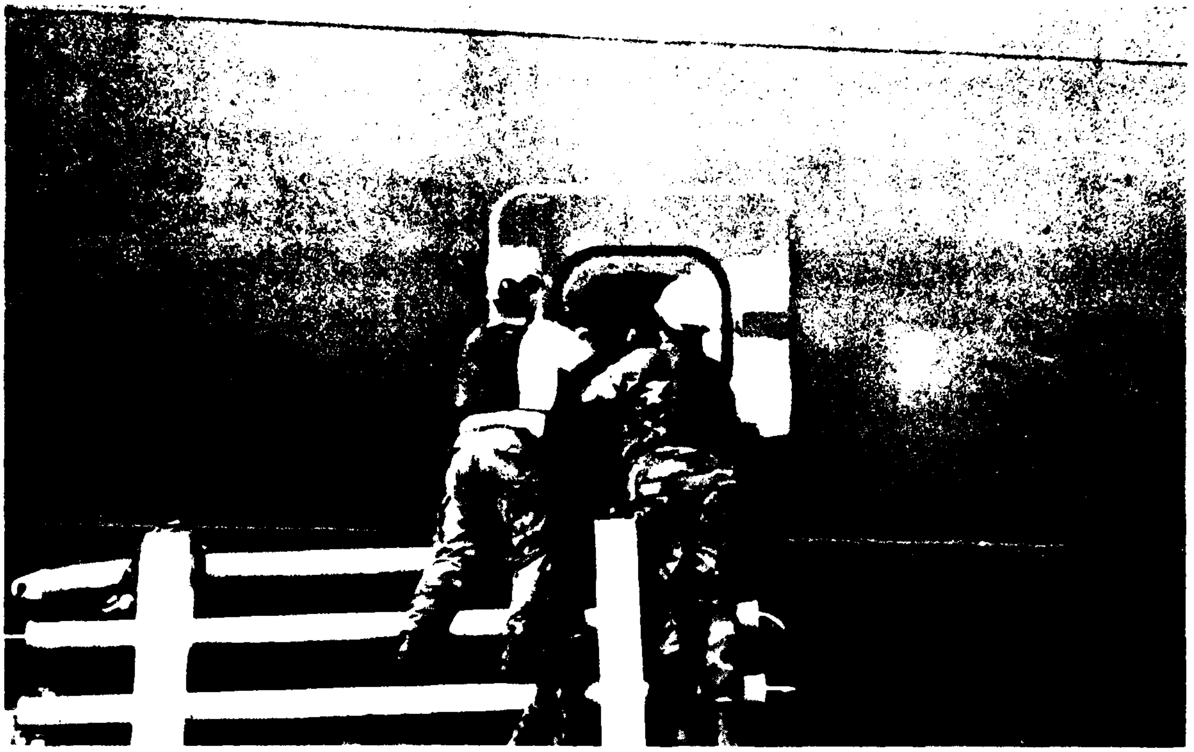


Figure 38 - Installing Mooring Line From CPF Fender Assemble

Test Results. The CWR was raised and secured on 17 September and remained so until 20 September when it was lowered, raised, secured, and finally lowered. The following items were noted:

a. The ship's drag tackle did not have enough cable to reach the CWR. Extension pendants, fabricated specifically for the test, were used to provide the extra length necessary (Figure 39). Also, the lift/drag wire ropes chafed on the ship's structure as shown in Figure 39.

b. Connecting the drag and lift blocks was awkward, difficult, and somewhat dangerous as there was no easy way to bring them to the CWR shackles (Figure 40).

c. Once connected, the ramp slid easily until it had to rise onto the fender assembly structure. Once up on the assembly, it slid easily again.

d. The extension pendants were removed once the ramp was on the fender assembly beneath the port. Once again, the connection of the block to the CWR was difficult.

e. A considerable delay was encountered when removing a piece of wood jammed against one of the Z-brackets in its support (Figure 41).

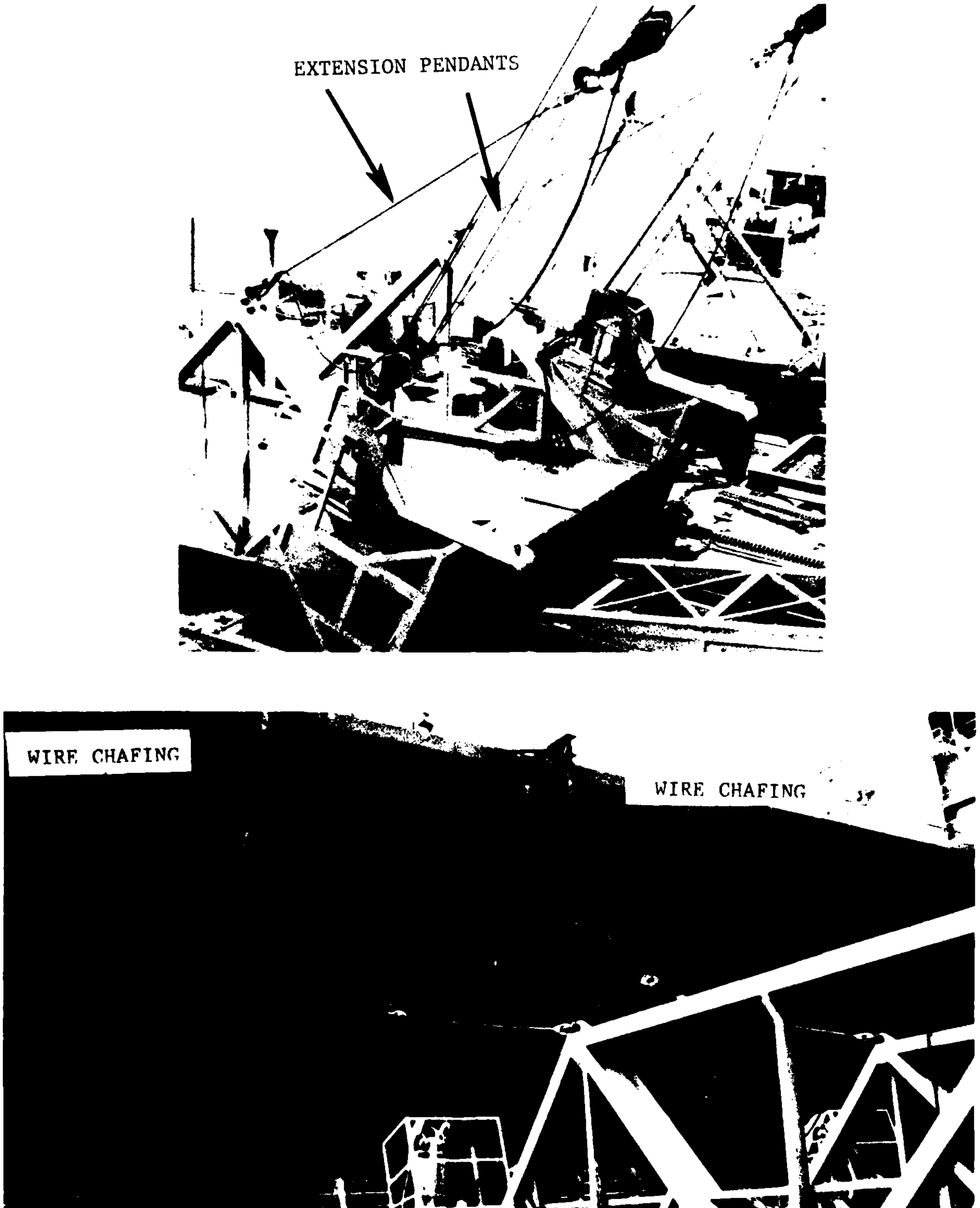



Figure 39 - CWR with Drag Line Extension Pendants

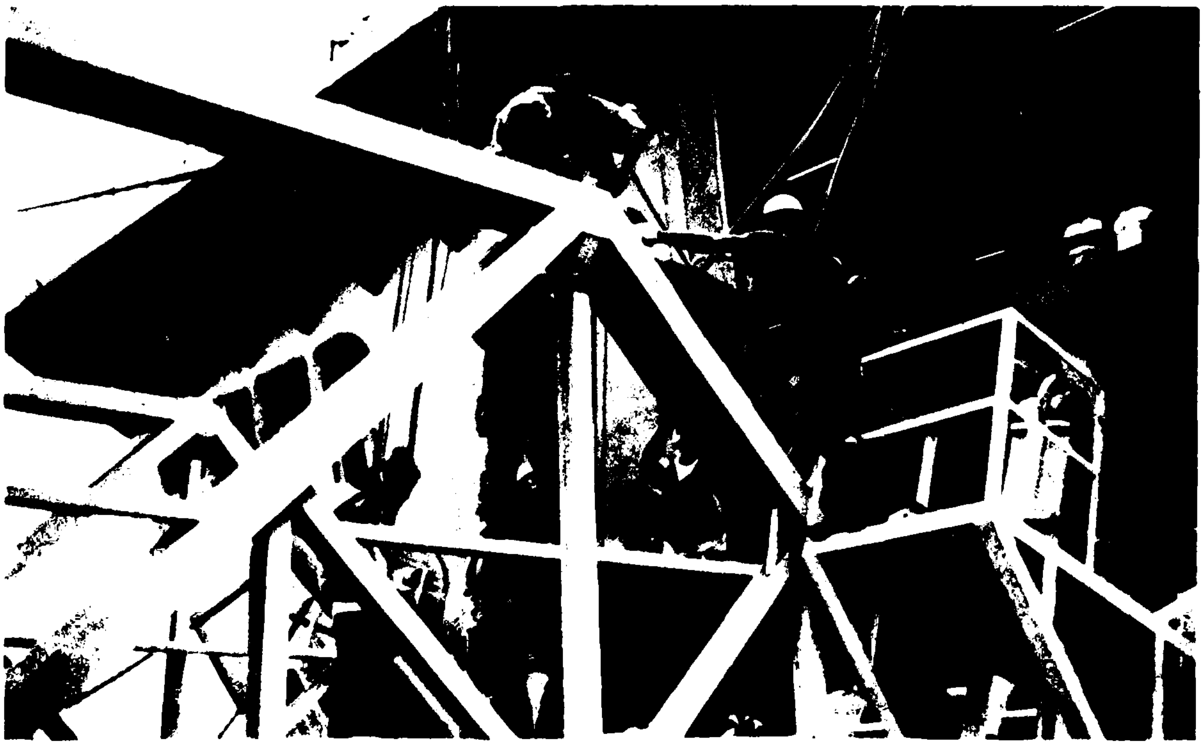


Figure 40 - Connecting CWR Drag Blocks

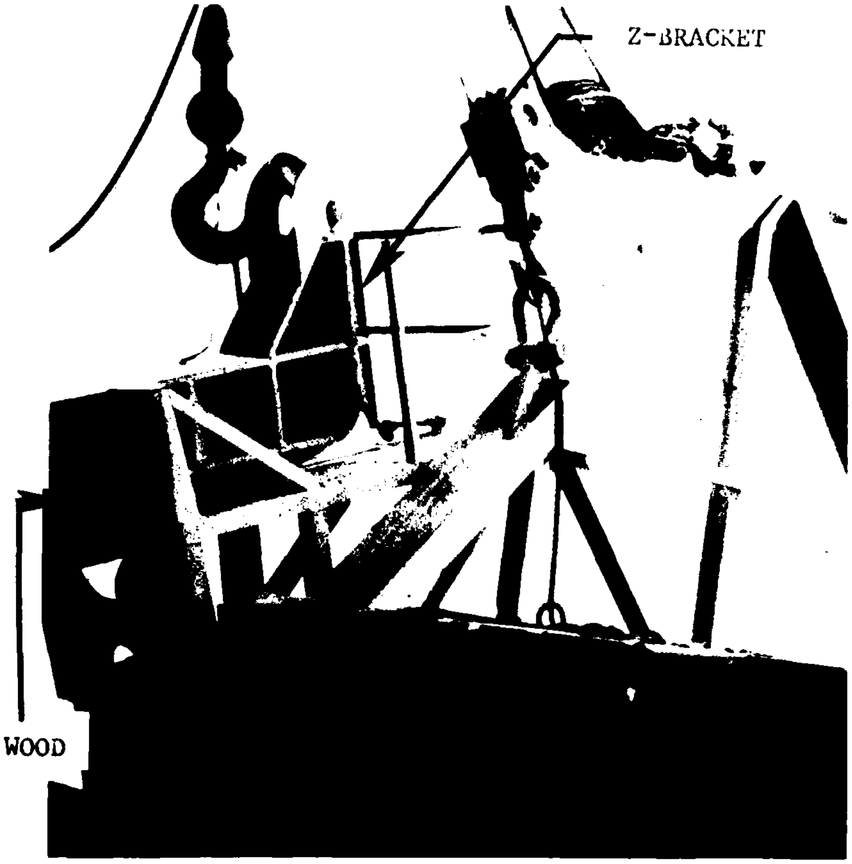



Figure 41 - Wood Wedged Against Z-Bracket

f. Once in position at the ship's offloading port, the Z-brackets did not fit onto the support pads. This was caused by their resting too far back on their supports. They were lifted and brought forward into position using a forklift provided by the ship.

g. While the raising process was relatively smooth, it was apparent that due to platform motion it was probable that only one set of lift or drag tackle may support the ramp during the initial connection and tightening of cables.

h. The lowering operation, which followed the procedure set forth in the technical manual, was satisfactory (Figure 42).

Test Conclusions.

1. The CWR can be safely raised and secured to the offloading port using the ship's existing ramp handling winches in sea state 0-1.

2. Raising and securing the CWR to the ship can be enhanced by lengthening the ship's drag cables so as to eliminate the need for the 15 ft long extension pendants (a drag block tackle extension capability of at least 55 ft is required).

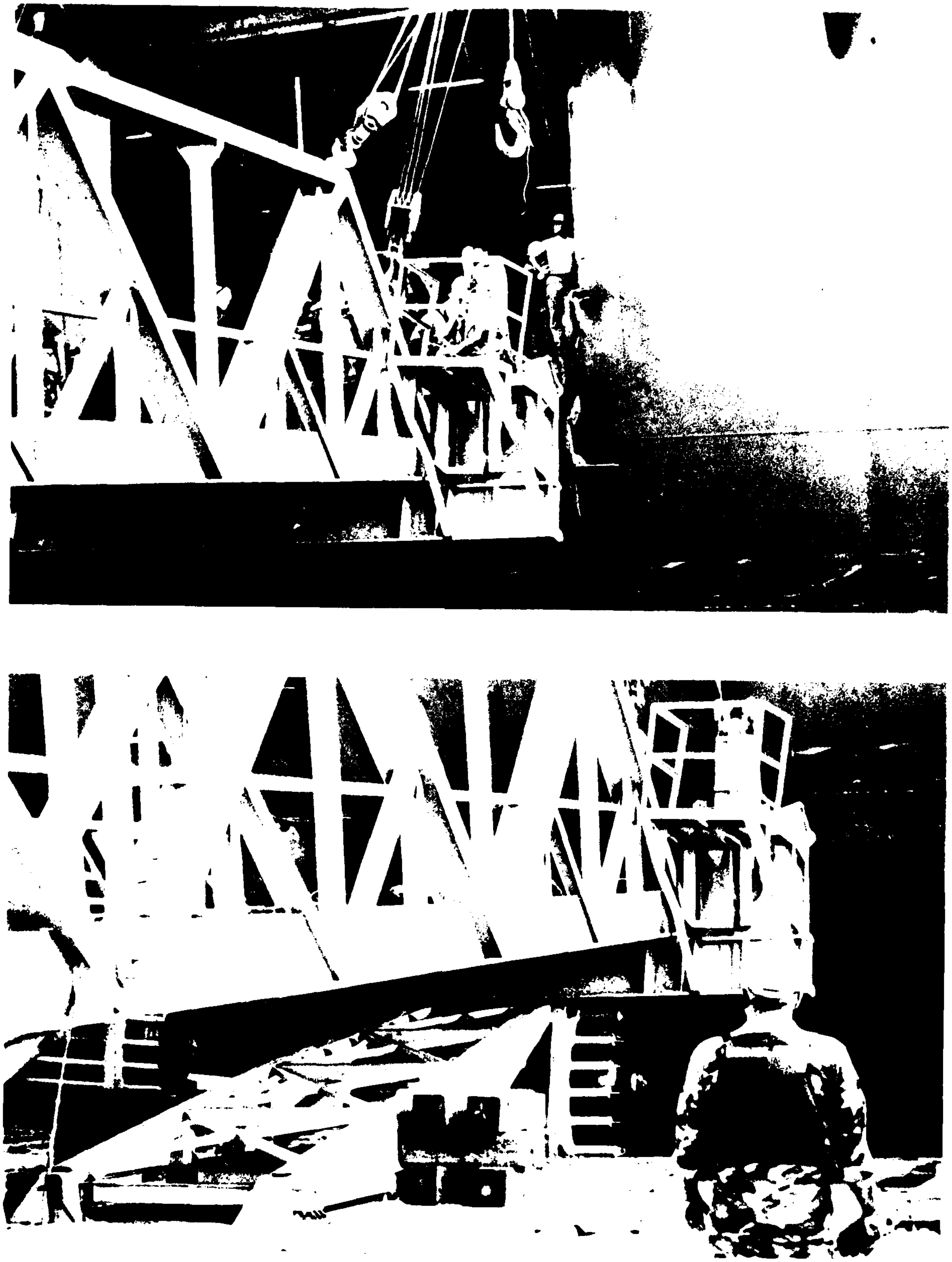


Figure 42 - Lowering CWR

3. The wire rope chafing (Figure 39) was considered unique to the SS ATLANTIC BEAR and will be corrected once the ship is placed in commercial service.

4. The ramp raising and lowering system has been improved through design changes following the test by:

a. Providing a block and tackle system to bring the lift-drag blocks to the CWR easier and under more control.

b. Revising the fender assembly so as to allow the ramp to slide up onto it more easily and with less force required.

c. Revising the CWR so as to position the Z-brackets correctly instead of allowing as much latitude in their position.

d. Providing motion limits in the final technical manual for the lifting operation so as to avoid the possibility of overstressing the ship's ramp handling tackle.

Objective 4

To determine the suitability of the ship's ramp pendants and related ship equipment to support and align the ship's end of the CWR.

Test Results. Once in position, the Z-brackets were connected to the support pendants and the lift/drag tackle was slacked. The CWR was held satisfactorily in position. The following items were noted:

a. There was movement of the Z-brackets in their pad supports.

b. The Z-Brackets rubbed against the support plate for the conventional ship's ramp (Figure 43).

c. The Z-bracket/support pendant system allowed as much as 5 degrees of "rotation" of the ramp. This resulted in damage to the CWR's Z-bracket support/personnel platform (Figure 44).

d. A temporary set of pendants was rigged from the ship to the ramp to prevent excessive ramp motion away from the ship (Figure 45).

e. The Z-bracket support pads were greased to reduce wear because of the Z-bracket's motion.

Test Conclusions

1. The existing ramp support pendants and related ship's equipment satisfactorily support and align the ship's end of the CWR in Sea State 0-1.

2. By adding pendants between the CWR and ship to restrict CWR

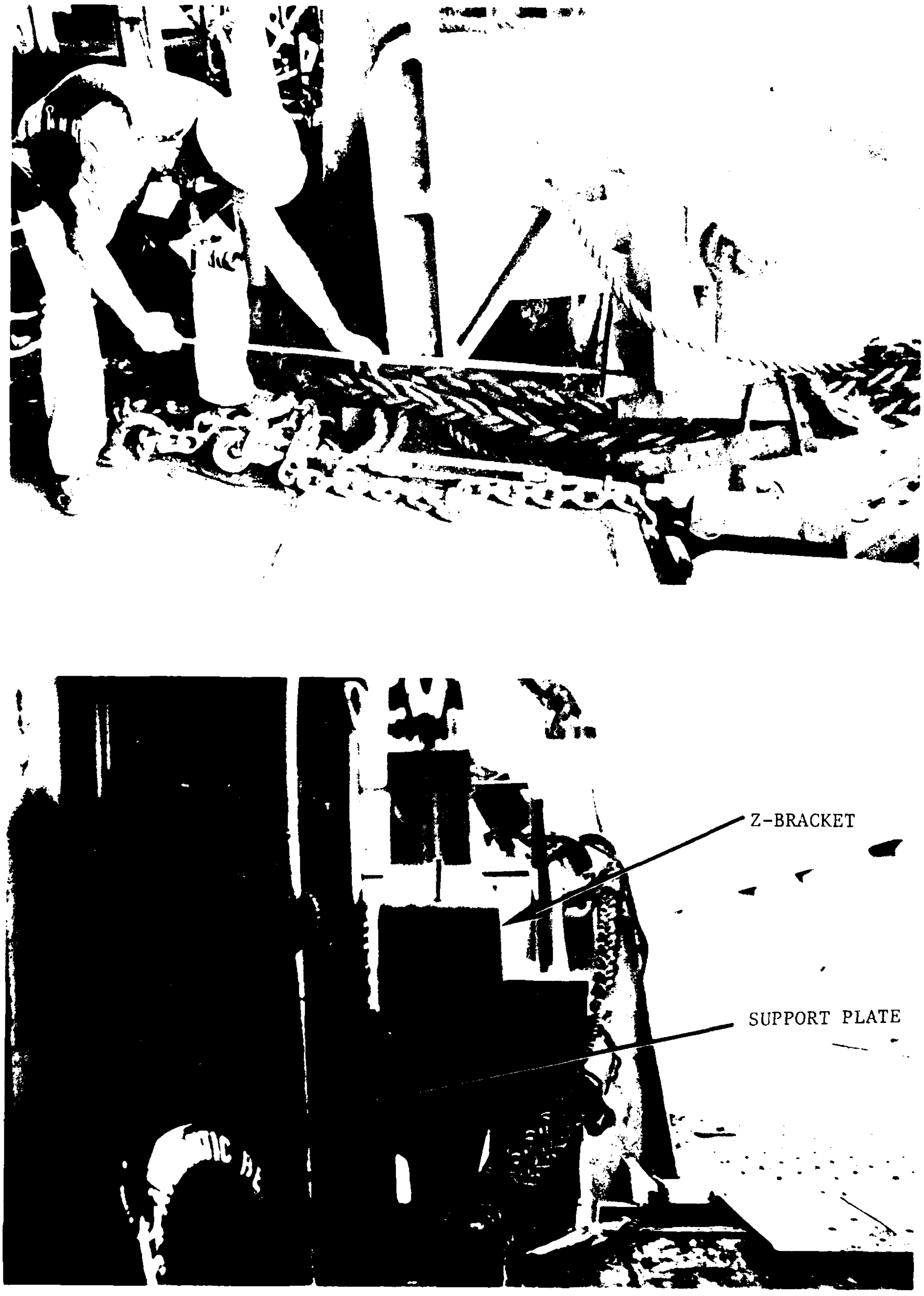



Figure 43 - Z-Bracket/Hemanski Hook Interface



Figure 44 - CWR - Personnel Platform Damage


Figure 45 - Ship/CWR Pendant

horizontal motion away from the ship, the CWR can be supported and aligned safely in up to Sea State 2 conditions.

3. The ramp support system has been enhanced through design changes following the test by:

a. Providing pendant systems to prevent excessive ramp movement away from the ship.

b. Revising the Z-brackets to eliminate interference with the existing ship's structure.

c. Revising the CWR's Z-bracket support/personnel platform so as to allow ramp rotation without contact against the side of the ship.

Objective 5

To determine if Causeway Ferries/LCUs can be properly secured to the causeway platform while the platform is moored to the ship and with the CWR attached to the ship's offloading port.

Test Results. As was expected and determined previously during CPF testing with the AMERICAN TROJAN[5] Causeway Ferries and LCUs can readily marry to the platform in Sea State 0-1 with slight wind and current but LCUs are hampered by increasing sea state, wind, and current. One problem not previously noted was that when marrying Causeway Ferries to the platform it is possible to twist the platform beneath the offloading port (Figure 46). When this occurred one of the lift cables parted as it was overloaded under tension. The CWR, which was supported by the support pendants and Z-brackets, was not adversely affected.

Test Conclusions.

1. As concluded in earlier tests[5] it was found that Causeway Ferries and LCUs can be readily married to the CPF under calm sea conditions (Sea State 0-1). As winds and seas increase, the presence of a Causeway Ferry already married eases the marriage of additional ferries or an LCU (Figure 47).

2. Operational procedures have been improved following the test by:

a. Specifying in the technical manual the requirement for slacking the CWR lift and drag tackles (once the CWR is secured in place) sufficiently to avoid overloading them if the CWR is rotated severely.

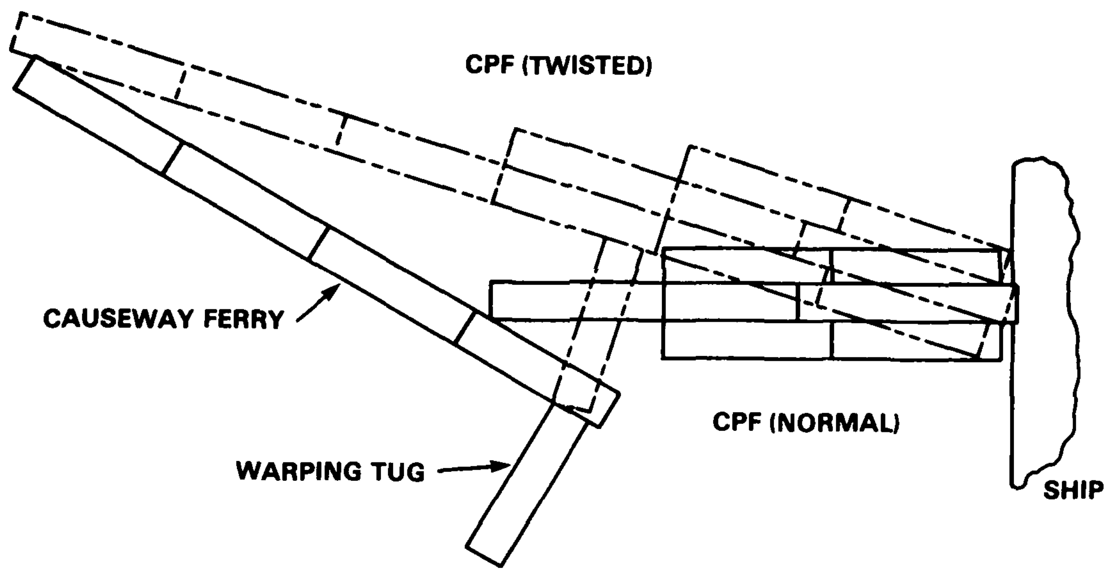



Figure 46 - CPF Rotation During Causeway Ferry Marriages

Figure 47 - LCU Approaching B Section

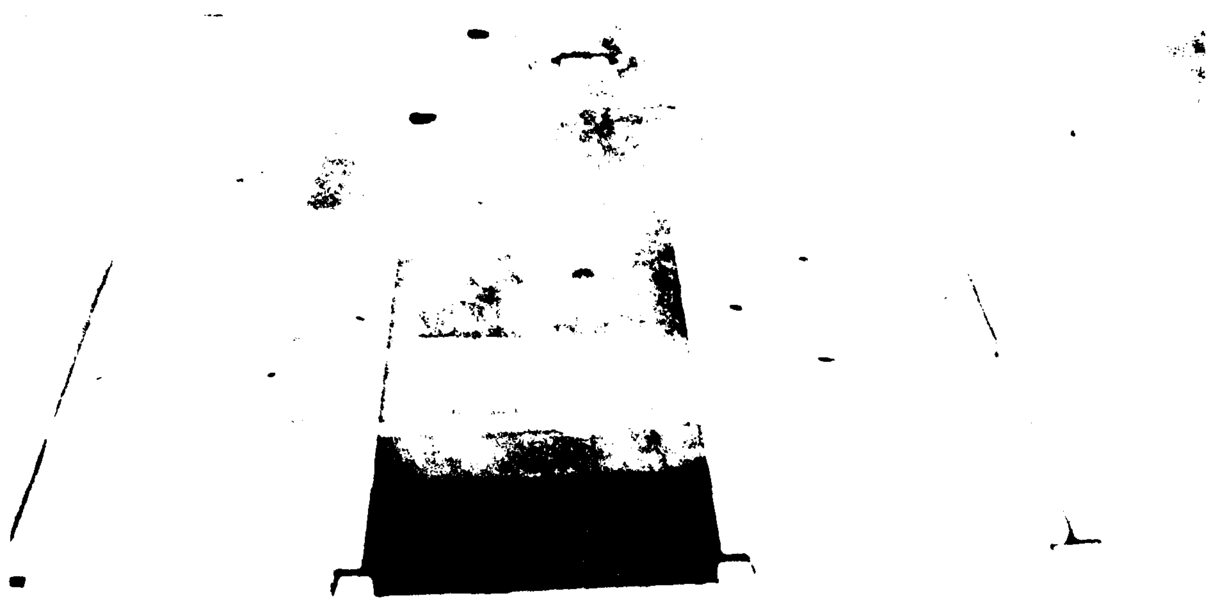
b. Clarifying Causeway Ferry/LCU mooring procedures in the system technical manual.

Objective 6

To determine if the test vehicles can be safely offloaded from representative shipboard vehicle stowage onto Causeway Ferries/LCUs.

Test Results. No difficulties were encountered during offloading operations. On one occasion a jeep's wheel rolled into the small space in the middle of the CWR between the CWR to ship flaps. This space was also a safety hazard for traffic directors who could step into it. A steel plate was welded to one of the adjacent flaps to eliminate the problem (Figure 48). All of the test vehicles were offloaded with no difficulty (Figure 49).

Test Conclusions. Vehicles can be safely offloaded from the ship onto lighterage via the CWR.



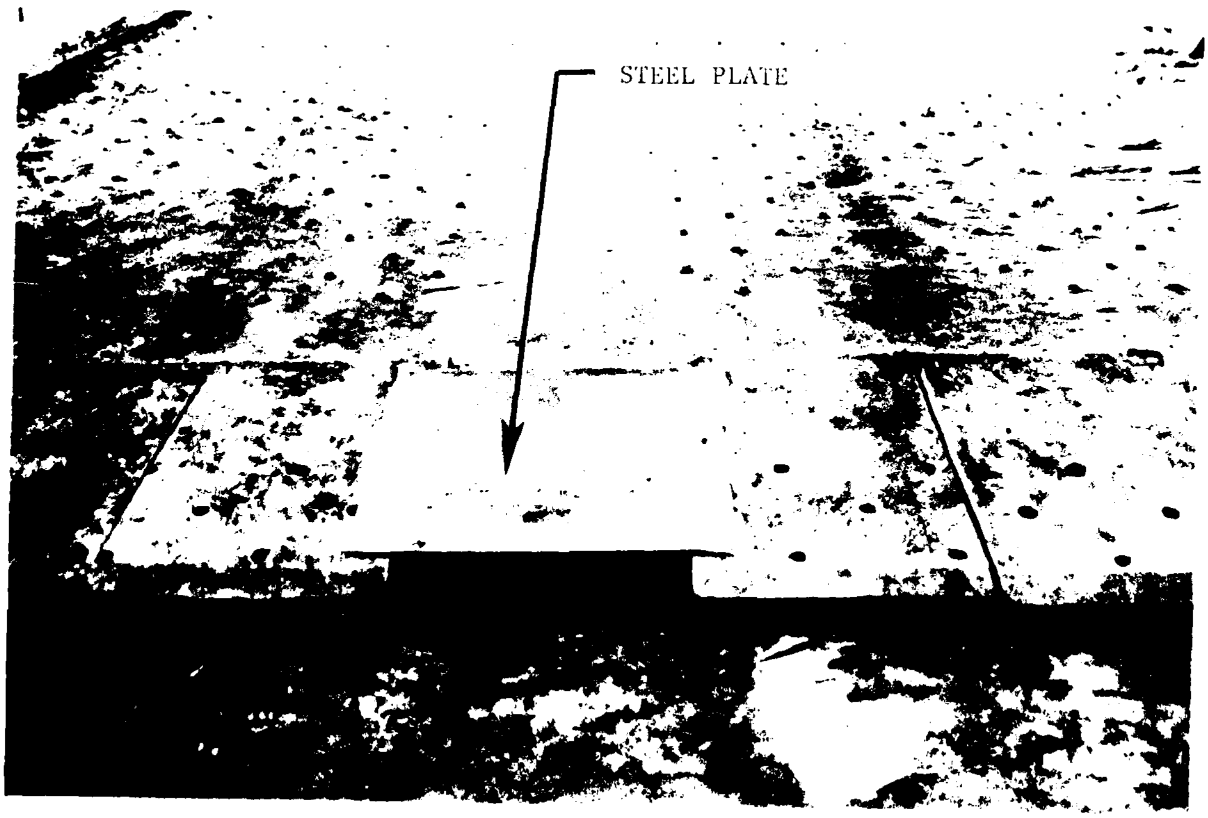



Figure 48 - CWR Vehicle Flaps at Ship

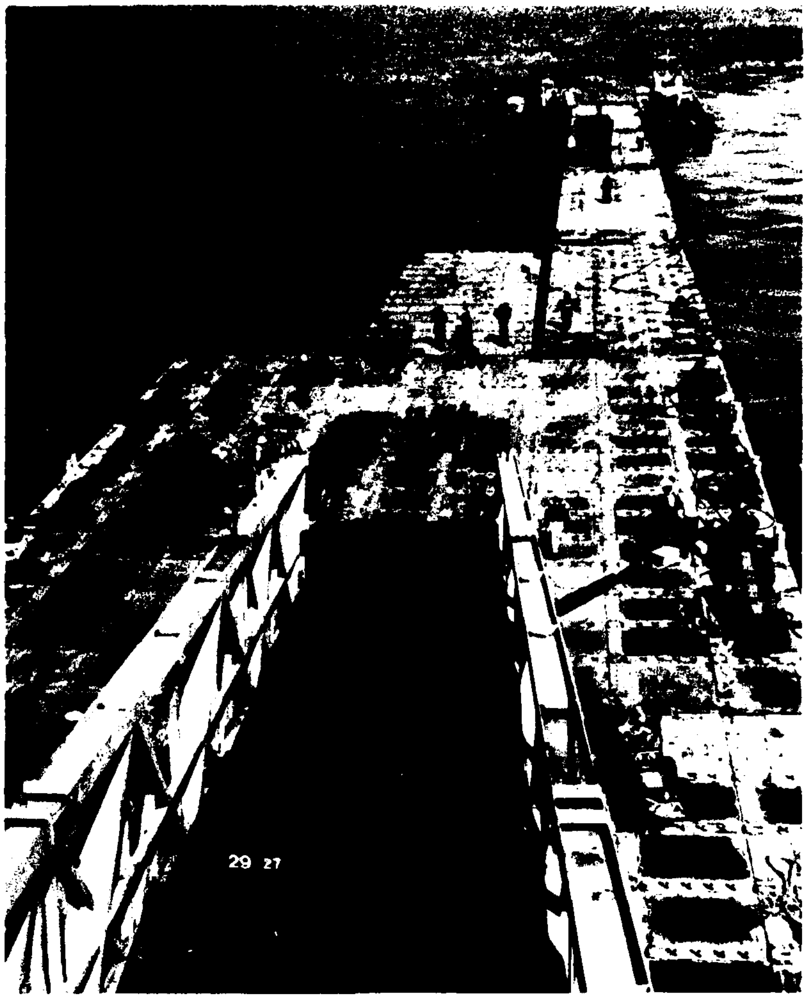



Figure 49 - Vehicle Offload From SS ATLANTIC BEAR

Objective 7

To determine if test vehicles can be safely retrograded onto the ship.

Test Results. No difficulties were experienced during retrograde operations.

Test Conclusions. Vehicles can be safely retrograded from lighterage to the ship via the CWR.

Objective 8

To assess vehicle performance when transiting an inclined CWR from the causeway platform to the ship and when transiting from the ship to the causeway platform.

Test Results. Vehicle performance was satisfactory throughout the test. Ramp angle was 11 deg (Figures 49 and 50).

Test Conclusions. Vehicle performance, either up or down an inclined CWR, is satisfactory.

Objective 9

To evaluate the load carrying capability of the CWR related ramp supporting apparatus.

Test Results. No damage occurred to the ramp support apparatus.

Test Conclusions. The CWR related ramp supporting apparatus is satisfactory.

Objective 10

To assess all of the test objectives under a dynamic test environment to better define sea state/relative motion limitations in Sea State 0-2 conditions.

Test Results. Table 3 summarizes the environmental conditions, SS ATLANTIC BEAR motions, and CPF motions during the test. The tests with the SS ATLANTIC BEAR were conducted under a dynamic test environment, ranging from Sea State 1 to 3, thereby helping define sea state/relative motion limitations.

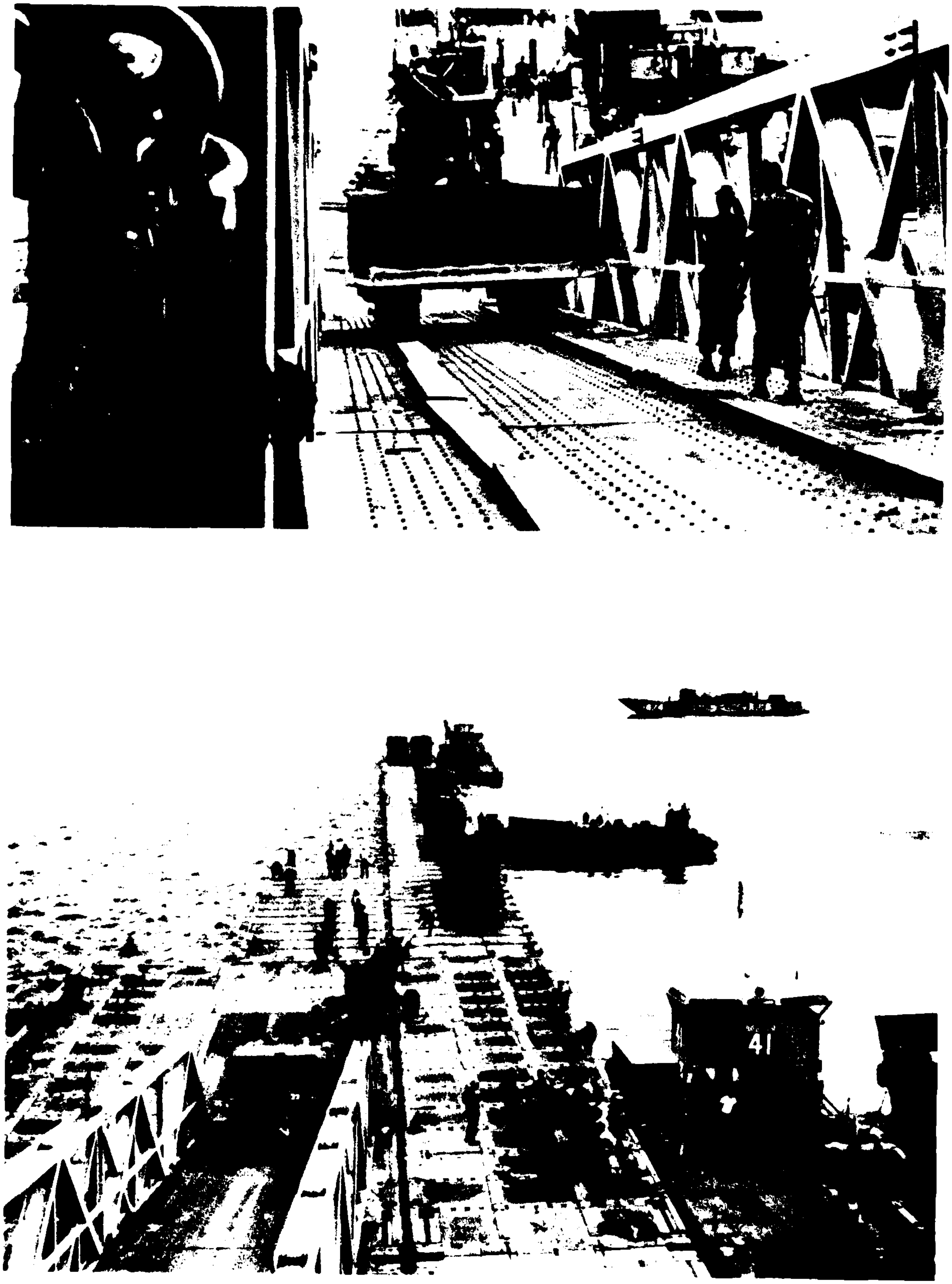



Figure 50 - Vehicle Retrograde Onto SS ATLANTIC BEAR

Table 3 - SUMMARY OF ENVIRONMENTAL CONDITIONS & MOTIONS OF THE SS ATLANTIC BEAR and CPF
(Range Values: Minimum - Maximum)

| | Test Date Times - September 82 | | | | |
|---|---|---|---|---|---|
| | 16th | 17th | 18th | 19th | 20th |
| | 1000-1300 | 0900-1805 | 0800-1714 | 0830-1700 | 0820-1346 |
| Winds (knots) | 5-10* | 2-11 | 2-7 | 1-12 | 1-13 |
| Currents (knots) | 0-1.2 | 0-1.2 | 0-1.3 | 0-1.0 | 0-1.1 |
| Temp-Air (°F) | 71-72 | 70-85 | 72-83 | 73-91 | - |
| Wind Direction (deg) | NE* | 211-297 | 018-339 | 023-355 | 080-286 |
| Wave Direction | NNE | WSW | NNE-N | N | W |
| Ship Heading (deg) | 308-042* | 328-107 | 311-029 | 100-291 | 118-282 |
| Ship Pitch (deg)** | - | 0-0.5 | 0-1.70 | 0-0.5 | 0-0.4 |
| Ship Roll (deg)** | - | 0-1.9 | 0-3.6 | 0-1.1 | 0-1.1 |
| Ship Accel (g) | - | 0-0.07 | 0-0.06 | 0-0.01 | - |
| CPF Pitch (deg)** | 3-10* | 1-6* | 0-4.40 | 0-2.0 | 0-1.3 |
| CPF Roll (deg)** | 3-6* | 1-7* | 0-5.3 | 0-3.1 | 0-1.9 |
| CPF Accel (g) | - | - | 0-0.06 | 0-0.09 | 0-0.04 |
| Max Wave Hgt (ft)*** | 4.0-8.0* | 2.3-3.8 | 2.3-3.5 | 1.2-7.6 | 1.1-1.9 |
| Sign Wave Hgt (ft) | 2.5-4.0* | 1.4-1.8 | 1.4-2.0 | 0.7-2.6 | 0.6-1.0 |
| Sea State**** | 2-3* | 1-2 | 1-2 | 1-2 | 1 |

*Estimated values
**Double amplitudes
***Range values of the mildest conditions to the most severe conditions encountered during the entire testing period.
****Pierson-Moskowitz sea spectrum

Test Conclusions. The Test and Evaluation Master Plan (TEMP) goal was for calm water operations, Sea State 0-1. The goal was satisfied or exceeded in all test objectives with operations being successfully conducted in the Sea State conditions noted below:

| | Test Objective | Sea State |
|---|---|---|
| 1. | To confirm that the Calm Water Ramp (CWR and Causeway Platform Facility (CPF) assembly procedures were adequate. | 1 |
| 2. | To establish the minimal number of resources (equipment, personnel, warping tugs/tender boats, etc.) required to assemble, transport, position and moor the CPF at selected offloading ports (transom and/or side port). | 1-assemble<br>3-transport<br>1-position & moor |
| 3. | To determine the suitability of raising the CWR up to the ship's offloading ports and securing it to the ship using the ship's existing ramp handling winches. | 1 |
| 4. | To determine the suitability of the existing ship's ramp pendants and related ship equipment to support and align the ship's end of the CWR. | 2 |
| 5. | To determine if Causeway Ferries/LCUs can be properly secured to the causeway platform while the causeway platform is moored to the ship and with the CWR attached to the ship's offloading port. | 2 |
| 6. | To determine if the test vehicles can be safely offloaded from representative shipboard vehicle stowage onto Causeway Ferries/LCUs. | 2 |
| 7. | To determine if the test vehicles can be safely retrograded onto the ship. | 2 |
| 8. | To assess vehicle performance when transiting an inclined CWR from the causeway platform to the ship and when transiting from the ship to causeway platform. | 2 |
| 9. | To evaluate the load carrying capacity of the CWR related ramp supporting apparatus. | 2 |

Objective 11

To evaluate the procedures of the system preliminary technical manual and other system support documentation.

Test Results and Conclusions.

1. Athough the system technical manual addresses the CPF quite extensively, numerous specific procedures were determined to be desirable. The following items, minor in nature, have been incorporated into the final technical manual:

a. Assign AOIC or other experienced person to be on the ship to coordinate CPF mooring and raising and lowering the CWR.

b. Describe the procedure to mouse hooks if safety catches are missing. Specify proper material.

c. Describe the procedure to center ramp on platform centerline when lowering.

d. Describe the use of a flag signal as an emergency stop signal to the ship to halt CWR movement.

e. Indicate the use of a Causeway Ferry as a pier to improve B section marriages (LCUs).

f. Add warning to manual so OIC is aware that Causeway Ferry mooring can rotate platform and could damage the CWR and the ship.

g. Specify grease on Z-bracket feet and shackles, on fender frame, and on fender cushions.

h. Add warning for ships crew to ensure slack on drag and lift lines because of DF rotation.

i. Describe and locate the equipment locker, tools, and spare equipment on the CPF.

j. Add the various ways to reconfigure the RO/RO Discharge Facility.

k. Note need to remove closure plates and to tiedown the CWR during rough sea transient operations.

l. Add warning for the brakes on all vehicles to be tested before being driven down the CWR. Note the need for a wrecker or other suitable vehicle to move vehicles with defective or questionable brakes.

2. The following list summarizes the post test drawing changes which were accomplished after the test to improve RO/RO Discharge Facility equipment operations:

a. CWR Design Changes:

(1) Z-brackets interfere with ship's structure (Hemanski Hooks). Modify Z-brackets to eliminate interference.

(2) Add two padeyes on ship end of ramp for preventers.

(3) Provide preventer chains with shackles for installation by ship's force once ramp is in place.

(4) Modify CPF wood platform to keep wood dunnage from shifting.

(5) Provide larger diameter lock pins for CWR lower joint pins. Provide larger diameter handles on joint pins to eliminate possibility of damage if the SEABEES use the handles as a fulcrum point for pry bars during pin removal.

(6) Center platform foot on CWR is required. They also should be lighter, easier to install.

(7) Ensure that non-skid surface is specified on entire ramp feet area.

(8) Add padeye bosses on CWR lift pads.

(9) Redesign ship end I-beam. Reduce length of I-beam. Ensure that castelated nuts with cotter pins are specified. Also ensure that adequate access is provided for these fasteners.

(10) Center CWR flap at ship is required. All flaps should be longer.

(11) Reconfigure stowage brackets for Z-brackets.

(12) Design system to bring hooks to lift/drag pads, ease hook up and detachment.

(13) Eliminate CWR skid plate and lubrication holes in CWR feet and teflon; add drain holes. The skid plate and lubrication holes to reduce friction are not required.

(14) Z-bracket securing device is needed to ensure they are aligned with deck pockets as ramp is pulled into the ship's port.

b. Fender Design Changes:

(1) Eliminate top support pipe.

(2) Attach fenders in a different manner. Provide padeyes on pipe support frames similar to where the chains were attached.

(3) Grease fittings needed for pivot pin.

(4) Stops need to be reconfigured to maintain initial vertical fender orientation.

(5) Sloped center fender ramp to be the same as frame slope.

(6) Reduce length of fender support pipes to eliminate corner contact with ship when platform is misaligned.

(7) Provide chain binder/turnbuckle to adjust fender to suit contour of aft sideport.

(8) Add additional support bracket to fender structure to distribute vertical loads.

(9) Mark foundations; center, port, and starboard to insure that the foundation bolting patterns match.

(10) Remove lower fender padeyes to prevent puncturing of the three CPF watertight cans (pontoons).

(11) Provide alignment guides on frame to ease crane lift on alignment.

c. Discharge Facility (Platform) Design Changes:

(1) Add chocks to the causeway platform.

(2) Add chain binders for CWR tiedown during transit.

## CONCLUSIONS

### MV CYGNUS TEST CONCLUSIONS

The results of the tests with the MV CYGNUS and the RO/RO Discharge Facility have shown that "The Facility can safely and efficiently discharge and/or embark military vehicles from a self-sustaining merchant RO/RO vessel in Sea State 0-2 conditions".

The following general conclusions have been drawn from the results of various aspects of the test. They are intended to be used in conjunction with those conclusions drawn from previous tests (DT-IM-3)[4]. Specific conclusions for each test objective are found in the Summary of Test Results.

1. The CPF can be assembled, transported, positioned, and maintained in the astern mooring position with two attending craft given environmental conditions not exceeding Sea State 2.

2. The use of a small inflatable type dinghy provides a quick and

efficient means of initially attaching the CPF mooring lines to the ship's padeyes.

3. When Sea State 2 operations are anticipated, pre-rigging of the mooring lines from the ship will simplify and make the mooring operations easier and faster.

4. The hydraulic station protection gear is a satisfactory means of keeping the ramp's lifting cables from coming in contact with the ramp's hydraulic piping. The cradle which has been redesigned to be lighter will be faster and easier to install and remove.

5. The deck closure plates between the causeway sections were found to be of sufficient strength to support all types of vehicle traffic. They were found however, to have a tendency to ride up out of the openings and fall into the water when wheeled vehicles rode along the outside edges of the closure plates. This problem was eliminated by simply tying the plates together.

6. The preliminary technical manual addresses all facets of the Discharge Facility Operation. The final edition of the manual will include more in-depth discussion of particular operations and procedures.

7. LCU bow marriages to an attached B section are made more secure by pulling the ramp lifting chains to obtain enough chain slack for two chain links to rest on the LCU's ramp. After this is completed vehicles can be allowed to transit the ramp.

8. The Test and Evaluation Master Plan (TEMP) thresholds for the offloading facility tests with the MV CYGNUS were all satisfied as indicated below:

| | THRESHOLD | ACHIEVED DURING* DT-II/JLOTS II |
|---|---|---|
| Reliability | .75 | No failures |
| MTBF (hrs)** | 35 | No failures |
| MTTR (hrs)** | 9 | No failures |
| Availability | 0.8 | No failures |
| Installation Time (hrs) | 4 | Approx 1 hr |
| Vehicles Discharge Rates (individual vehicles/ 20 hr day) | | |
| Sea State 0 | 200 | Approx 310 (490)*** |
| Sea State 1 | 150 | Approx 310 (490)*** |

* Preliminary data. Final projected throughput rates will be contained in the JLOTS II, Phase II Test Report.

** Mean Time Between Failures (MTBF) and Mean Time to Repair (MTTR)

*** (490) represents the projected discharge rate for individual vehicles of a representative ship loadout plan which considers a truck and trailer unit as two vehicles. These rates assume a scenario of three 4-section Causeway Ferries being used with the RO/RO anchored 2,000 yards off the beach.

SS ATLANTIC BEAR TEST CONCLUSIONS

Based on the offloading tests with the SS ATLANTIC BEAR, the following concluding statement can be made, "The RO/RO Discharge Facility can safely and efficiently discharge and/or embark military vehicles from a nonself-sustaining merchant RO/RO vessel in Sea State 0-2 conditions." However mooring of the CPF to a side port and raising/lowering the CWR can only be safely conducted in Sea State 0-1 conditions.

The following general conclusions have been drawn from the test results. Specific conclusions for each test objective are found in Summary of Test Results.

1. The CWR, platform fenders and CPF can be easily assembled by following the procedures and manning levels called for in the technical manual.

2. The CPF with CWR and fenders can both be assembled and moored at the aft side port by using two attending craft (e.g., one CSP and one SLWT).

3. The ship's existing ramp handling winches, ramp support pendants, and related ship's equipment satisfactorily move and support the ship's end of the CWR.

4. Mooring and ramp handling operations can be improved to allow Sea State 2 operations by making the following additions and/or modifications to the nonself-sustaining RO/ROs:

a. Providing ship installed (i.e., pre-rigged) mooring line pendants at the recessed Dutch bollards.

b. Lengthening the ship's drag cables to allow attachment of the drag blocks directly to the ramp in a one step operation.

c. Replacing all four wire ropes on the ramp handling winches with new high strength independent wire rope core (IWRC). Install new drag and lift blocks which have safety latches, quick release features, and swivel. Proof test each winch and pendant support system.

d. Installing two deck mounted padeyes or D-rings to provide a place to attach the ramp preventer pendants.

e. Install a radiused plate on the starboard transom edge to enable the use of mooring lines run through the transom chocks and around the corner to the CPF.

5. Causeway Ferries can be readily married to the CPF in Sea State 0-1. In Sea State 1-2 the process becomes more difficult, but it can be eased when one of the platform attending power units positions itself to provide an alignment guide for the ferry and the other CPF attending craft assists the ferry.

6. Under calm sea condition (Sea State 0-1) LCUs can be married to a attached to the CPF. The process becomes increasingly difficult, if not impossible, as winds and currents increase (Sea State 2). The addition of a Causeway Ferry to the CPF aids the marriage process, especially during periods of increased wind and current.

7. Nonself-sustaining (NSS) RO/RO operations utilizing side ports will be more difficult in worsening sea states as compared to stern ports. For those NSS RO/ROs with both side ports and stern ports, only stern ports should be used for offshore operations.

8. The system technical manual and other support documentation are satisfactory. However, the manual and engineering drawings have been revised to reflect the lessons learned during the test events.

9. The Test and Evaluation Master Plan (TEMP) thresholds for the offloading facility tests with the ATLANTIC BEAR were all satisfied as indicated below:

| | THRESHOLD | ACHIEVED DURING DT II/JLOTS II* |
|---|---|---|
| Reliability | .75 | No failures** |
| MTBF (hrs) | 35 | No failures |
| MTTR (hrs) | 9 | No failures |
| Availability | .80 | No failures |
| Installation Time (hrs) | 4 | Approx 2 hrs |
| Vehicles Discharge Rates (units/ 20 hr day) | | |
| Sea State 0 | 200 | Approx 310 (490)*** |
| Sea State 1 | 150 | Approx 310 (490)*** |

* Preliminary data. Final projected throughput rates will be contained in the JLOTS II, Phase II Test Report.

** One fender assembly was damaged and required repairs before testing could continue. However this failure is not considered a chargeable faulure for purposes of RM&A analysis since the failure mode has been removed by redesign.

*** (490) represents the discharge rate for individual vehicles of a representative ship loadout plan which considers a truck and trailer unit as two vehicles. These rates assume a scenario of three 4-section Causeway Ferries being used with the RO/RO anchored 2,000 yards off the beach.

## AFTER TEST ACTION SUMMARY

1. The RO/RO Discharge Facility technical manual, engineering drawing, and other support documentation have been revised to reflect the Improvements and Enhancement Features documented in the Summary of Test Results and Conclusions sections of this report.

2. A nonself-sustaining ship modification package (specifications and engineering drawings) will be developed for use by MSC and the Maritime Administration. In the event of a military need to utilize one of these commercial ships, this package can be included in the MSC ship charter requirements. These simple RO/RO ship modifications, which can be accomplished in one or two days, would improve mooring and CWR raising and lowering operations (see the Conclusion section) and enable operations to be conducted in Sea State 2.

3. A new research task, under the Fleet Logistics Readiness Technology Program, has been initiated and exploratory developmental work is underway to investigate a full Sea State 3 RO/RO ship offloading capability.

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