NAVAL FACILITIES ENGINEERING SERVICE CENTER
Port Hueneme, California 93043-4370

# TECHNICAL MEMORANDUM
## TM-2103-AMP

# FLEXOR MARRIAGE BRIDLE TESTS

by

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This is a presentation of the initial tests conducted by the Naval Facilities Engineering Service Center (NFESC), Port Hueneme, California, involving the use of wire bridles to end connect Navy Lightered (NL) causeways. Amphibious Construction Battalion ONE, Coronado, California provided the assets necessary to demonstrate conventional equipment and methods used in such marriages. Modifications to the rigging arrangement and procedure resulted in safer, quicker, and more controllable connections. Hardware and operational improvements are suggested for inclusion in subsequent tests that are intended to improved the use of existing equipment as well as provide criteria for next generation higher sea state systems. The funding is provided by the Office of Naval Research under Replenishment Project RM33F61 of the Navy Exploratory Development Program LH2A - Facilities and Material, as well through the Sealift Support Program directed by the Civil Engineering Support Office (CESO) and the Naval Facilities Engineering Command (NAVFAC).

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## CONTENTS

## LIST OF FIGURES

## INTRODUCTION

Demonstrations of the Flexor marriage bridle system were conducted during the week of 10-14 January 1994 in conjunction with Amphibious Construction Battalion ONE (PHIBCB-ONE), Naval Amphibious Base (NAB), Coronado, California. The demonstrations were in support of ongoing tasks at the Naval Facilities Engineering Service Center (NFESC), Port Hueneme, California, that are directed toward providing the Fleet with safer and more capable lighterage for amphibious operations. The Coronado demonstrations revealed a number of hardware and operational items that could be modified to provide PHIBCB operators with more control and safer equipment in the conduct of bridle-assisted connections with the existing Navy Lightered (NL) causeway system. Equally important data were gathered for consideration in developing the next generation of lighterage, and a series of follow-on tests are being prepared to refine the various developmental concepts under consideration. An attempt to verify the ability to connect Flexors in a 3.5-foot sea was unsuccessful because of an unusually calm weather cycle that could not provide more than 1-foot swell in the operational area. Testing marriage bridle gear in marginal weather conditions remains an important requirement because it is exactly those conditions that dictate some additional measure of control (i.e., marriage bridles) be employed to effect the Flexor connections.

## TEST PREPARATION

The tests were conducted on 13-14 January 1994. Figure 1 shows typical hardware laid out and prepared for use. The hardware list included the equipment cited in the test plan (Appendix A) as well as PH-11 padeyes, wire straps, and anchors (for ballast weights). Figure 2 presents the wire bridle legs, consisting of 1-inch wire straps 55 feet long, with swaged soft eyes approximately 18 inches long. The pendants in Figure 3 were also made of 1-inch wire, swaged eye construction, and measured approximately 5 feet in length. The snatch blocks were 18 inches in size and are produced by two different manufacturers: Crosby-Laughlin (Figure 4) and McKissick (Figure 5). The PH-11 padeyes were drawn from the onboard inventory that is typically carried on a side loadable warping tug (SLWT) used in Maritime Prepositioned Force (MPF) onload operations. Three SLWTs and three intermediate roll-on/roll-off (RO/RO) causeway sections were provided with a pair of Flexors installed in one end of each of the intermediate sections. The crew members were briefed on the purpose and sequence of each test, and were encouraged to contribute any suggestions that they felt might be helpful. A log of test operations and execution times is included as Appendix B.

## PHASE 1

The first demonstration of a bridle marriage used textbook techniques as documented in NAVFAC P-401 Pontoon System Manual, and taught to prospective craftmasters undergoing SLWT training at the PHIBCB school, Coronado. A schematic of craft and gear is presented in Figure 6. In brief, the sequence requires that all bridle gear be staged on board the causeway section (CW #1) tied alongside SLWT #1, and that a second SLWT approach with the section to be connected in tow. The oncoming section (CW #2) approaches with Flexors extended and crew ready to receive the messenger lines from the first platform.

During the actual maneuver, it became apparent that the crew had little experience in rigging gear or performing the procedures as outlined in NAVFAC P-401. The only personnel familiar with the operation were the craft masters. The general lack of exposure resulted in time-consuming delays while snatch blocks and rigging were positioned. Once the sections closed to within 30 feet, crew members from CW #1 heaved the messenger lines. As the two SLWTs attempted to maintain a separation of 25 to 30 feet, crew members on CW #2 crawled out over the extended Flexors and attached the bridle lines. Although the weather was calm and the water was glassy, the very nature of that procedure was potentially dangerous; personnel overhanging the section were in a precarious position and were unable to maintain constant watch on CW #1. Once the bridle legs were secured, SLWT 2 broke off and connection proceeded with few problems.

## "FREESTYLE" MARRIAGE

In the "frostily" type of marriage, bridles are not used. Rather, the two sections are brought into close proximity by the SLWT operators until the "timing is right." The bow of one of the tugs overlaps the end of the adjacent causeway section and forms a pocket to help guide the incoming section. The SLWTs push the causeways together as the shear connectors engage, and the tugs then hold the sections in place until the Flexors are fully engaged. Although the union is made unassisted, it takes skill and coordination to orient Flexor with Flexor housing as the final push is made. In the actual test sequence, SLWT #2 was brought back into position and reconnected alongside CW #2 to control it while bridle legs and Flexors from the first demonstration were disconnected, thus again freeing the two sections. With the sections still floating in close proximity, a "frostily" marriage was completed by the operators, with only their own handling skills and signals from the deck Petty Officer to guide them. Figure 7 shows the configuration of craft and causeway used in this "frostily" marriage. It took three attempts within a 4-minute period before success was realized, a number considered normal for the prevailing weather and sea conditions.

## PHASE 2

Phase 2 tests were conducted to demonstrate an alternative approach to those procedures presented in NAVFAC P-401. Figures 8 and 9 show the relative marriage positions of warping tugs and causeway sections as employed during most of the Phase 2 tests. The rationale behind this configuration of warping tugs has to do with improved safety and maneuverability. With both SLWTs heading into the prevailing seaway, maneuverability and seaworthiness aboard

each craft increases, while at the same time crew members are protected from seas that could otherwise swamp the low-riding sterns. After bridle hardware staged on the trailing section is passed and secured to CW #1, SLWT #1 steams ahead with CW #2 in tow, all the while winching the sections together.

The continuous forward motion of SLWT #1 serves to stabilize the sway of the trailing section, allowing it to "weathervane" as it lines up and mates with CW #1. The required deck rigging is similar to that called out in NAVFAC P-401, and there are no differences in the types or quantities of gear required. However, the passage and connection of messenger and bridle lines is done in a manner that eliminates the requirement for personnel to put themselves in harms way by putting arms and legs between the sections. Bridle legs are preconnected at will to extended Flexors on CW #2 and only later passed to CW #1 for attachment to the "A" wire. A short line also prerigged through the P-8 receiver on CW #1 allows the bridle legs to be reeved with no bodies required over the end of the sections, thus resulting in an overall safer operation.

In the field, the concept was validated. Operating in the modified configuration produced faster and safer marriages with overall greater control than witnessed during the Phase 1 tests. During the demonstration, the snatch block tie down on CW #1 was changed from a wire strap wrapped around a double angle to a PH-11 padeye bolted in one of the four positions available on the causeway deck. These arrangements are shown in Figures 10 and 11, respectively. Although the PH-11 was not designed for that function, its configuration and strength lent itself to the application very well, and provided a certifiable hard point as opposed to a wire pulling over the edge of a sharp steel angle. Although the padeye was placed closer to the center of the causeway than was desired, it was fully functional with the short bridle legs.

The tests demonstrated that with only a couple of additional short straps prerigged to Flexor and receiver, crew members are able to maintain their footing and stay safely on deck during an entire marriage procedure. Operationally, SLWT personnel were much more comfortable with the control that this configuration offered. The connection times were shorter and there was less random motion between CW #1 and CW #2. However, there was a tendency for CW #2 to haul in at an angle (Figure 12), possibly in response to the discharge stream from the SLWT #1 waterjet and the effect of maneuvering on the part of the SLWT operator. This offset situation caused the "Y" bridle to shift to one side of the deck where it fouled on the bolt heads of the double angles. The fouling is a usual though undesirable occurrence in marriages with a "Y" bridle, but crew members using prybars were able to free the wire rope as it hung up.

The only significant drawback to this connection method is that, depending on the length of time required to effect a marriage, supporting craft may stray outside the original operational area. The next series of tests will address this problem by providing one or more means of restraining the string of causeways as they apply power.

## OUT-OF-TRIM SECTIONS

Although not a consideration in the original test plan, one important aspect of marriage bridle usage is the ability to function when engaged causeway sections are out of trim. Current load-out methods require that NL and task equipment be loaded aboard Seabee or Lighter Aboard Ship (LASH) vessels. Typically, the causeway sections are deck loaded with Elevated Causeway (ELCAS) or beach support gear that could be offloaded more easily if loaded sections were

formed into a ferry or pier configuration, and then beached. If the ends of causeway sections are more than 4 inches out of alignment, the connection of two is difficult or impossible.

Although the current application of bridle-assist hardware requires a clear deck, and as such is not compatible with operations that stage deck-loaded cargo, it is nonetheless informative to document the trim differential that may be accommodated by the wire rope bridle legs as the lower section is pulled up and into its counterpart.

To accomplish this demonstration, CW #2 was deck loaded with two 3,000-pound anchors and one 6,000-pound anchor as depicted in Figure 13. The anchors were placed so that the loaded end had a freeboard of 33 inches, whereas CW #1 remained empty with a freeboard of 41 inches. The 8-inch trim differential was too great to attempt a "freestyle" marriage, especially given the prevailing weather and sea conditions of dead calm, but the sections were successfully connected while steaming ahead in the same configuration used during the Phase 2 tests.

## FINDINGS

Overall, the tests exposed a number of opportunities for improvement in hardware and operational procedures. The changes proposed herein are offered in the interest of greater safety, improved maneuverability, extended hardware durability, and improved operational capability in elevated sea states. The following considerations are presented in no particular order of importance:

- PHIBCB personnel preferred to face the craft into the seaway as they carried out operations. The configuration used in the Phase 2 tests provided more control over the craft and causeways.

- Even while the craft were heading into a seaway, there was insufficient drag on the towed section to prevent it from surging toward the lead causeway. The total dynamic effect of elevated sea state is uncertain, but restraint on the stern of CW #2 (Figure 14) would be beneficial under most circumstances. Attachment to a fixed mooring would offer a significant level of restraint and also counter the problem of steaming away from the operations area while connecting causeway strings in the seaway. On the counter side, however, attachment to a fixed mooring system might limit maneuverability to the point that the potential gains in stability are not worth the risk. Other options include the use of drogues, sea anchors, and SLWT #2 backing down.

- When two or more sections are connected and the SLWT remains attached to the forward section, another SLWT should be available to assist maneuvering. There are configurations that place the SLWT #1's waterjets near the center of gravity of the assembled platform with very little turning moment. These configurations can be predicted and, if reconfiguration is not practical, another SLWT should assist.

- More standoff between sections is required during bridle connection. The length of the bridle legs is marginal for safe operations in any type of sea state, and is unacceptable for higher sea states. The bridle length is dictated by the position of the snatch block on CW #1 and could be increased if the block could be moved forward. Proposals for this capability are part of the test plan for follow-on tests.

- Fenders may be required between the SLWT and adjacent causeway in an elevated sea state. The hinge rails on the port side of the SLWT and causeway sections create a standoff that is more than the RF-1 type fenders on the SLWT can accommodate. Foam-filled fenders (minimum 24 inches in diameter) would provide protection between the craft, but their size poses handling problems for stowage and recovery.

- The 18-inch snatch blocks are cumbersome and difficult to transfer between sections. The weight of the blocks, especially the Crosby-Laughlin, are more than two men can safely handle on the deck of a causeway in an elevated sea state. The lighter weight McKissick 18-inch snatch blocks were easier to transfer between sections, but were significantly more difficult to reeve when rigging time was a factor. The size of the blocks can be reduced if dedicated 12- to 14-inch blocks are used (currently, the blocks used on marriage bridle operations are drawn from available stores of the lift/launch inventory).

- Deck closure plates do not allow a wire to be passed around the double angle in the necessary locations. The current method of snatch block attachment sometimes requires that a closure plate be modified or removed in order to accommodate a wire. The result is a damaged or missing grating that could cause personnel injury.

- Hard points for the connection of snatch blocks are inadequate. The increased emphasis on safety during all operations and especially the certification of all rigging gear requires the use of attachment points that can be tested and approved for safe working loads (SWL). The previous methods of pulling on a wire or chain bent under a double angle have not resulted in any known incidents of failure, but no chain or wire manufacturer will recommend the practice. The development of new attachment points or the adaptation of existing hardware will not only provide accountability and safer rigging, but the placement of the points could benefit the operation by permitting longer bridles and more flexibility in load configurations. Proposals for follow-on tests include the use of PH-11 padeyes as well as pontoon haul-back rings, both of which are available in the Federal stock system.

- The deck of the SLWT has no certifiable hard point for the attachment of a bridle snatch block that permits the block to be centered on the deck. A PH-11 type of padeye attachment is feasible at the first P8/P1 pontoon gap near the bow. The hard point and the method of attachment could be the same as recommended for use on the causeway sections.

- The "y" shaped marriage bridle tended to hang up on the bolt heads during connection operation. As the "A" wire pulled the two-legged bridle down the center of the deck, the bridle wire fouled on the assembly bolt heads and required a crewman with a pinch bar to free it. The procedure was potentially hazardous to the wire, sometimes caused delays in the in-haul operation, resulted in uneven pulls on the bridle legs, and was a possible safety hazard for the crewmen.

- Improved rigging arrangements greatly increase the safety of passing and connecting the bridle legs. The implementation of longer bridle legs, prerigged Flexors on CW #2, the use of 4-foot transitional straps on the ends of the Flexors, and other modifications to rigging hardware or procedures are improvements that offer significant gains in safety with a minimal impact on hardware or existing methods.

- Although the bridles and Flexors underrode the lead causeway on several occasions, there was no significant damage to the wires. The use of chain shackles (installed with clevis end toward the Flexor) is recommended to provide as smooth a transition as possible and to prevent the shackle from overturning (Figure 14). Bridle legs should be monitored during the in-haul process and inspected prior to reuse, but no significant change to the attachment rigging is required. The use of a 4-foot transitional section immediately ahead of the Flexor would improve the durability of the connection.

- The bridles can be used to connect sections that are out of trim by as much as 8 inches in calm water. With the existing connector design, the self-aligning capability of the marriage bridle system can be used to force the out-of-trim ends of two sections together. If the "big mouth" connector (as installed on the stern adaptor unit) is used on the female sides, another 4 inches of trim differential can be accommodated. Operations in rougher water would (to a point) enhance the connectability of these out-of-trim sections with either style of shear connector.

- The fairlead slot at the end of the P-8 receiver is a source of accelerated wear on the bridles. The passage of the wire under the round bar on the P-8 and over the corner of the adjacent P-1 pontoon is the most likely source of damage to the bridle legs. The resultant damage could be flattened or broken strands, fishhooks, corkscrewing, or breakage of the wire. The necessity for major modification to the pontoon structure is very questionable given the frequency of the affected operations. The best method for accommodating the deficiency on the existing assets is monitoring and inspection of the bridles during use. Future pontoon designs, especially any that might rely more heavily on bridles for connections, should provide a more suitable fairlead.

- Guillotines need to be of the correct design in order to work properly. It is possible to conduct "hands off" marriages by presetting the guillotines in a "half cocked" position. With the guillotines sitting on top of the locking bars, the incoming Flexor can pass beneath the guillotine, allowing it to ride up and over the head until it falls into the locking slots on the Flexor head. Many of the existing guillotines do not function well in this manner because of changes made to the original design drawings or due to modifications made at the Battalion level.

- The Flexors often jam against the entrance to the receiver unless they are well aligned. The design of the Flexor head results in an edge that can "two block" on the edge of the receiver entrance (Figure 15). This could be improved with a redesign of the head.

- The run of wire from the winch to the first sheave needs to be as long as possible and needs to be centered on the deck of the SLWT. In order for the wire to reeve onto the winch properly, the wire should be routed over the A-frame or the snatch block should be mounted as far forward as possible. The use of a fixed padeye at the bow should fulfill this requirement.

- Restraining chain or wires should be attached to the inboard ends of all Flexors. There is always the possibility of a Flexor overshooting the guillotine slot as it is being extended or retracted. A preventer line at the inboard end is a system requirement that will eliminate the possibility of a lost connector.

- Fleet personnel need to practice rough water marriages with and without the bridle system. The connection of causeways with or without marriage bridles is an operation that poses some inherent dangers. Calm water connections are often conducted in the harbor as a function of preparing for some of the tasks that are a part of the operational function of the Battalions. Rough water connections are avoided, if possible, and are frequently done at times that do not permit the luxury of experimentation, training, or an "easy-does-it" approach. Reports from the deck level of both PHIBCB-ONE and PHIBCB-TWO show that there is a lack of familiarity with the hardware and procedures, and virtually no training prior to an actual operation.

## SUGGESTIONS FOR FOLLOW-ON TESTS

A follow-on test plan will be developed to try the hardware and procedural improvements that result from this initial test. The results will be incorporated into the existing fleet training and operational methods and will also verify the design concepts for the next generation system.

Suggestions for follow-on tests are presented in the following:

- Modify the deck of the SLWT to accept a padeye on a PH-11 (Figure 16) type of base plate. The padeye should be capable of securing two snatch blocks under the full load of the winch (20,000 pounds). Modify a pontoon haul-back ring to use instead of a PH-11 (Figure 17) if the allowable loads permit. The haul-back ring is more easily stowed, can be dedicated to the marriage bridle rig, and prevents misuse of the PH-11.

- Modify the deck of one causeway to accept PH-11 or haul-back ring padeyes at the first gap inboard of the P-8 pontoons. Each padeye needs to be able to resist the load of the winch and the surge load of the sections. The placement at the ends of the sections could be marked to prevent confusion with the location of the PH-11s for loading aboard the MPF ships.

- Use longer bridle legs in conjunction with the new padeye locations on the deck of the causeways. If the padeyes are mounted at the extreme ends of the causeways, the bridle legs could be lengthened by at least 15 feet.

- Obtain smaller, lighter weight snatch blocks for use with the marriage bridles. Dedicated blocks with a smaller diameter sheave (grooved for 1-inch wire) would be much more manageable during transfer operations and could be stowed below deck on the SLWT.

- Consider using 7/8- or 3/4-inch bridles if the reduced size makes a significant difference in the size of the snatch blocks and rigging hardware. The size of the legs is a major factor in the selection of the associated hardware. If the wear factors can be controlled, a smaller diameter wire could provide the necessary SWL for the operation while reducing the weight and bulk of the gear.

- Fabricate a 48-inch urethane-encapsulated chain link between the Flexor and the bridle. This 4-foot transitional piece allows the personnel aboard CW #2 to stay safely on deck while connecting the bridle legs and could be designed to facilitate the in-haul procedure by providing a smoother transition and reducing the wear on the wire end connection.

- Install a mooring to use as a securing point for sections to be connected. Secure the single sections to the mooring at their stern and pull against it. Design and fabricate chain plate guillotines to secure the mooring to the section. Rather than an installed mooring, one SLWT could anchor with its stern wire and serve as a raft for the sections not being used. This would enable it to pass a line from its bow to the stern of the section to be married and restrain it.

- Instrument the padeyes to determine the loads that are actually seen at these locations. The results would be used to establish SWL requirements for all of the rigging gear.

- Investigate the possibility of obtaining a constant tension device to control the surge motion between the barges during a marriage. Would control of the "A" wire be better than individual control over each bridle leg?

- Fabricate a guillotine mounted roller fairlead to use with a P-8 pontoon. This would permit the placement of the padeye attachment points at the extreme ends of the sections and would provide a fairlead that could pass shackles.

- Operate the marriage bridle with the SLWT end connected to the string. This method would be especially suitable for forming causeway ferries.

- Configure the bridle system so that the bridle legs run from the SLWT to the outboard angles and run straight down the length of the CW #1 section (Figure 18). The legs would be fairled through the P-8 receivers and across to the Flexors of CW #2. CW #2 would be outfitted with two 90-foot bridle extensions that would enable the marriage of CW #3 with minimum equipment transfer. This method would permit the deck loading of causeways prior to end connection and would eliminate the fouling of bridle legs on the assembly bolt heads.

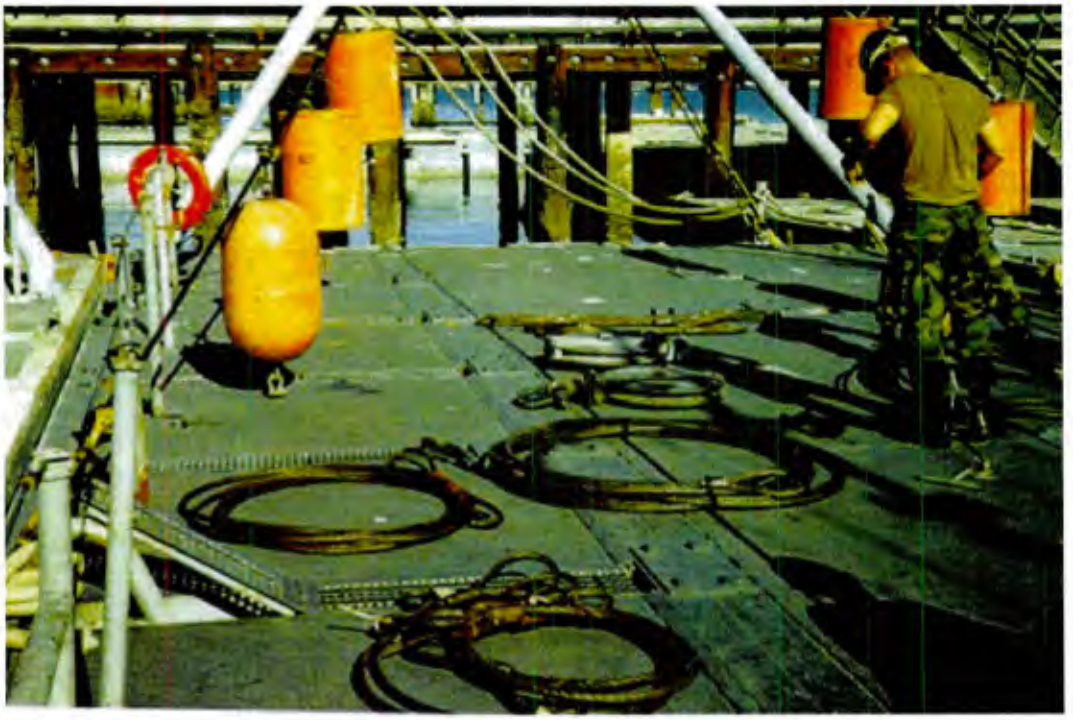

Figure 1
SLWT deck with wires and snatch blocks.

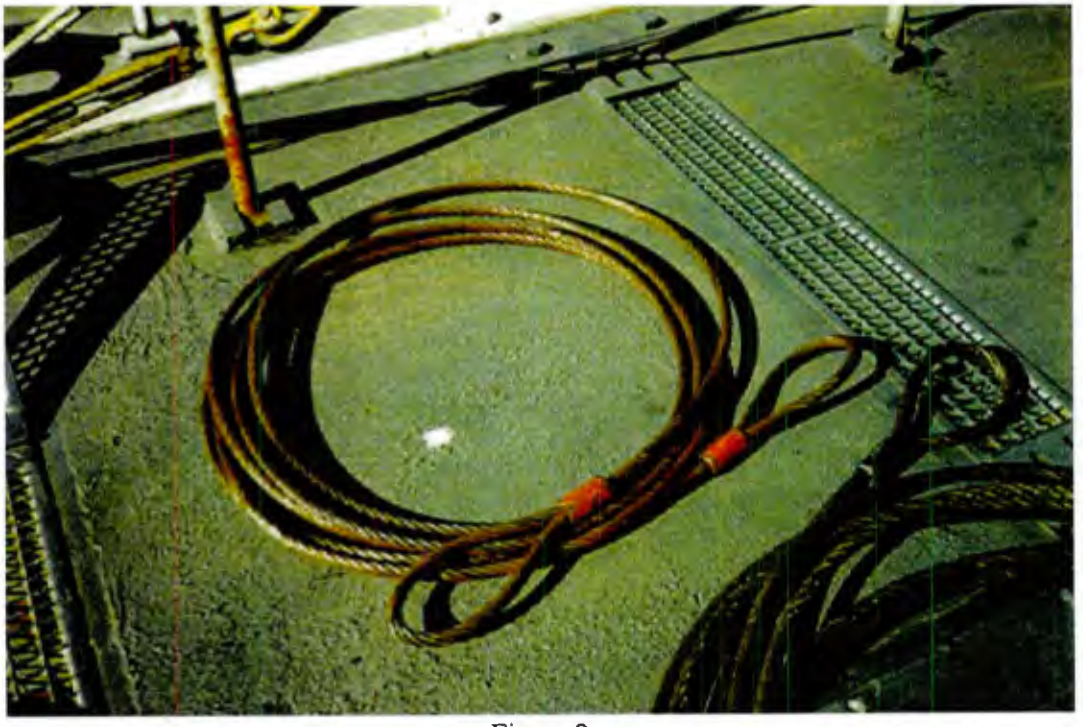

Figure 2
55-foot long bridle legs are formed from 1-inch wire rope.

Figure 3
5- to 7-foot long wire pendants.

Figure 4
18-inch Crosby-Laughlin snatch blocks.

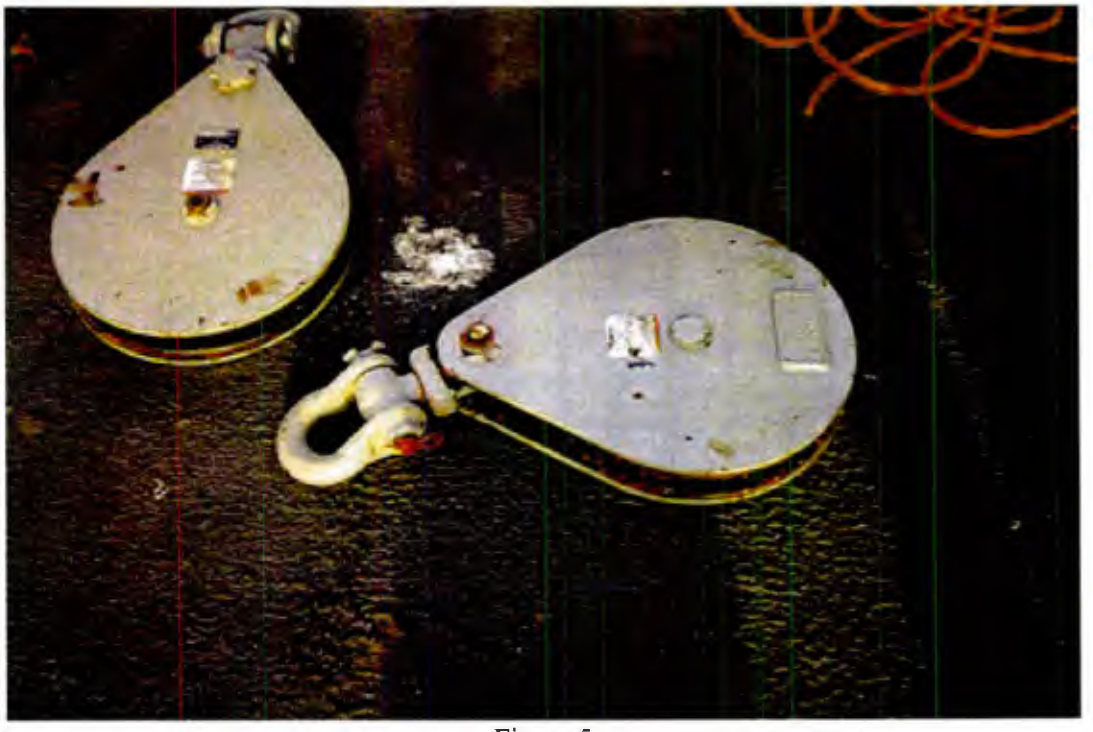

Figure 5
18-inch McKissick snatch blocks.

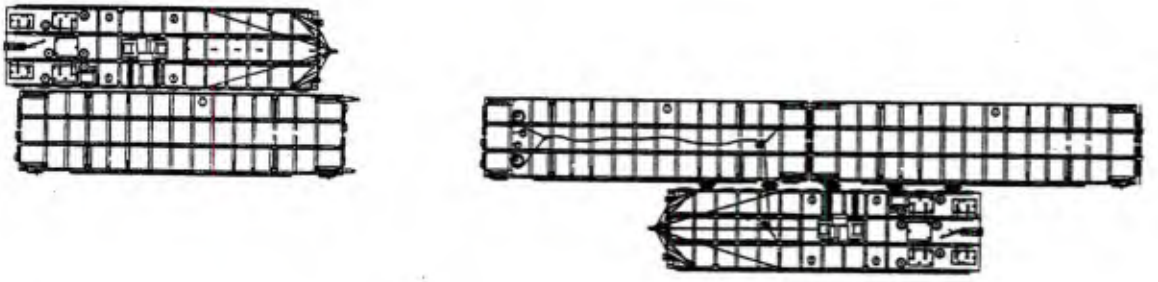

Figure 6
Current method of rigging for bridle-assisted Flexor marriages
(as per NAVFAC P-401).

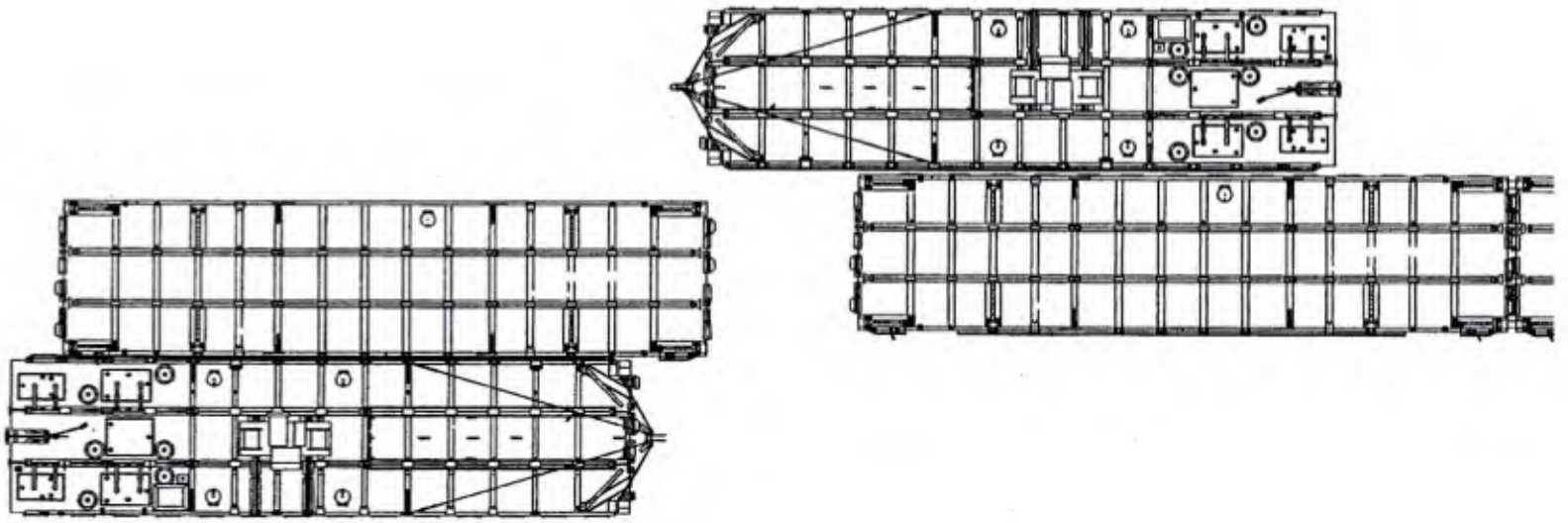

Figure 7
Unassisted method of marrying causeway sections.

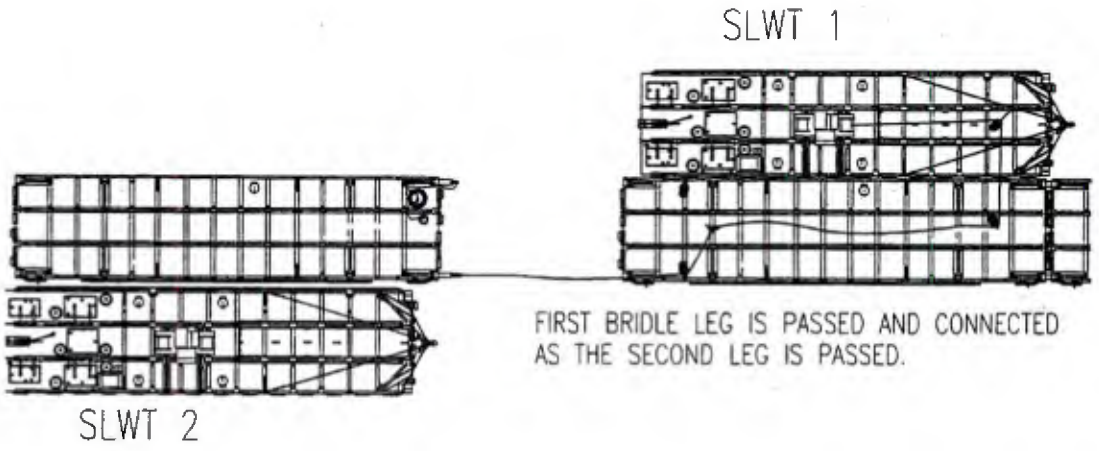


Figure 8
SLWTs maintain heading and relative positions as the
bridle legs are passed (Phase 2 tests).

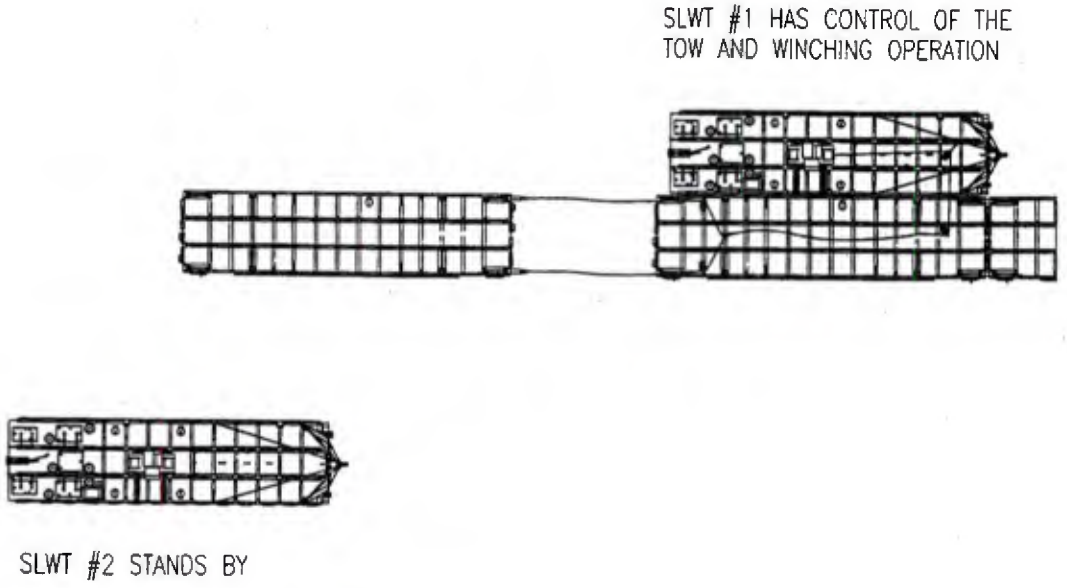


Figure 9
SLWT 1 ready to begin winching operations (Phase 2 tests).

Figure 10
Wire strap around angle and PH-6 padeye rigged to place
18-inch snatch block on the centerline of the causeway.

Figure 11
PH-11 padeye rigged to place 18-inch snatch
block on the centerline of the causeway.

Figure 12
Misalignment of sections during bridle inhaul.

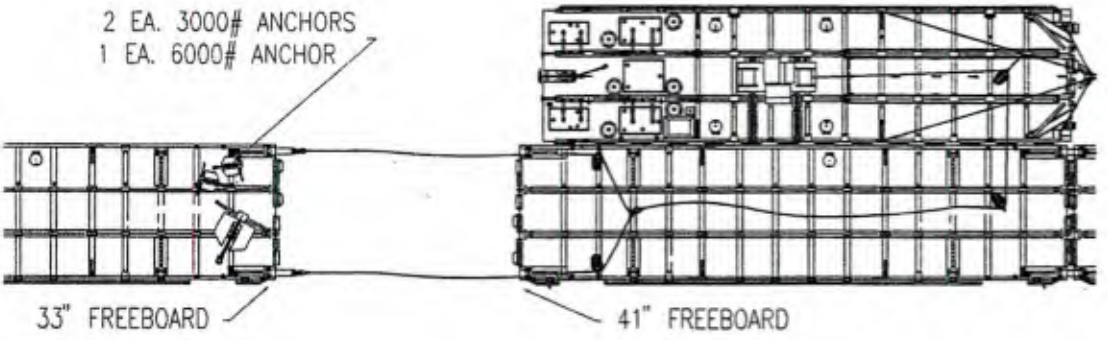


Figure 13
Connection of causeways with 8-inch trim differential.

Figure 14
Upset anchor shackles poses a potential jamming problem.

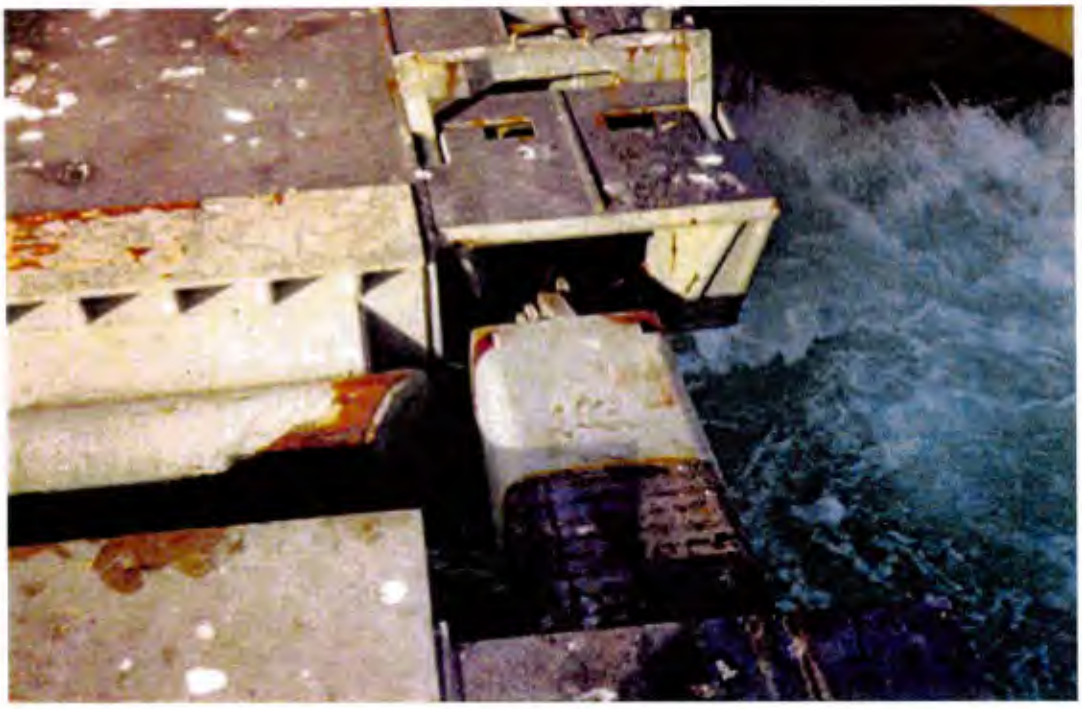

Figure 15
Misalignment of Flexor head and receiver
opening causes momentary binding.

Figure 16
PH-11 mounting position on double angle.

Figure 17
PH-11 padeye bolted to double angle.

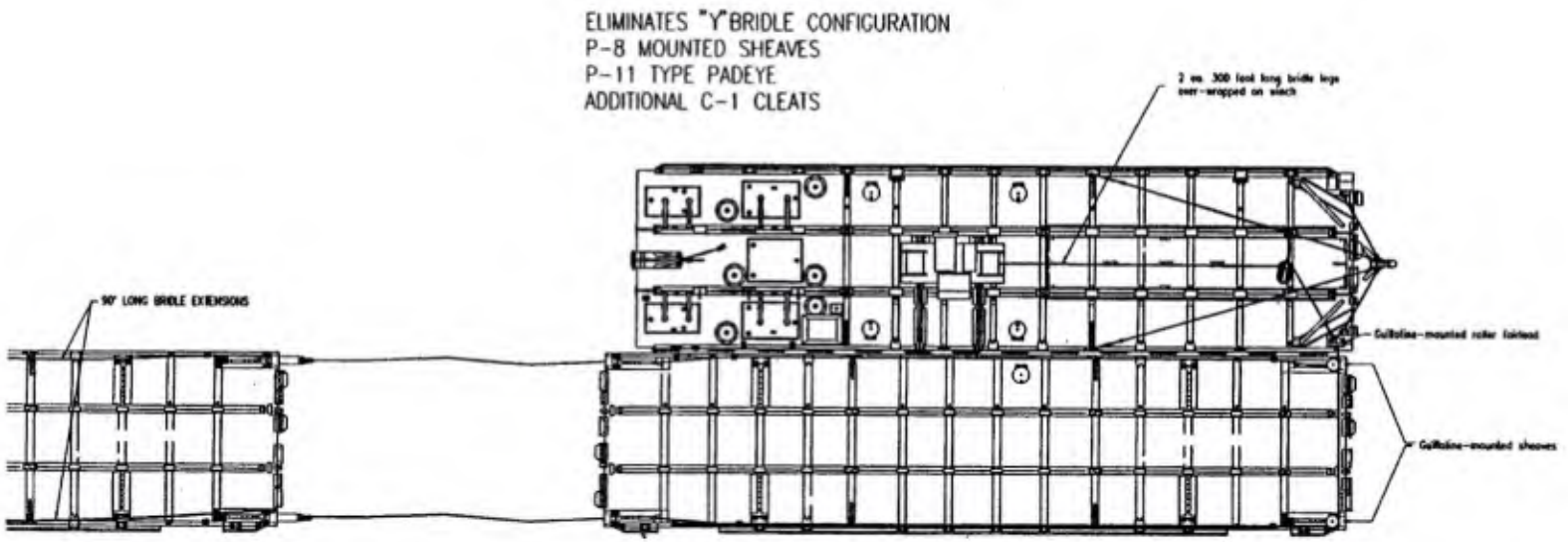


Figure 18
Bridle marriage with deck loaded cargo.

## Appendix A

## FLEXOR MARRIAGE BRIDAL DEMONSTRATION
## TEST PLAN
## AMPHIBIOUS CONSTRUCTION BATTALION ONE
## CORONADO NAVAL AMPHIBIOUS BASE
## 10-14 JANUARY, 1994

A series of operations has been coordinated with PHIBCB-ONE in an effort to identify hardware and equipment weaknesses in the Flexor marriage bridal system. The first effort will be a demonstration of the current PHIBCB method of conducting such operations and is intended to point out the areas of the current operation that need improvement. A follow-on test will be conducted in a few months to test the resultant improvements as well as to test the feasibility of some modifications that will enable the use of bridles with deck-loaded cargo and provide further input for the design of the next generation of causeways.

### APPROACH

A brief description of the marriage procedure is included in NAVFAC P-401, the Pontoon Gear Manual. Since this is the only official documentation addressing the operation, the first effort will duplicate that technique. PHIBCB-ONE personnel are tasked with being responsible for ability and proficiency in the conduct of this method, and are being asked to so demonstrate. This initial demonstration (Phase 1) will take place in a protected waterway with ample space for handling and maneuvering. Any phase of the operation that requires improvement will be noted and, if possible, modified in another trial of the same method.

Once the method according to doctrine has been tried, the assets will reconfigure and try a revised method (Phase 2) that has resulted from Fleet input and observations over the past several years. No significant equipment changes are necessary for this "improved" version. The most notable difference will be a reconfiguring of the positions of the warping tugs, enabling improved maneuvering and sea-keeping abilities. After the crews have had an opportunity to evaluate and become familiar with any variations in the methods, the team will be asked to demonstrate the marriage bridle technique in 3.5-foot seas (Phase 3).

The ability to connect causeways in sea state 3 is a design operational threshold for many of the NL assets, including the universal end connector system. There is a lack of documented proof that the marriage can be accomplished in a sea of this magnitude, and conflicting reports on the problems are frequently heard. Representatives from both PHIBCB-ONE and PHIBCB-TWO have recently agreed that the operation can be conducted in 3.5-foot waves, the low end of a sea state 3.

## OPERATIONAL PROCEDURES

During this demonstration, all procedures will follow or be derived from the guidelines set forth in the PHIBCB-ONE Operations Manual.

The senior Petty Officer in charge of the deck operations will have ultimate authority on any decisions regarding changes to the equipment or configurations.

At no time will any operation be conducted at the expense of personnel safety.

NFESC personnel will perform in the role of observers and will coordinate any on-site changes through the officer of the deck. NFESC personnel will provide their own safety gear including hard hats, safety shoes, and floatation vests or jackets. They will provide all of their own test equipment including radios, wave monitoring equipment, and cameras.

The tests will be coordinated with the tests of the boat barrier to avoid a conflict of craft requirements.

## TEST EQUIPMENT

Because this is a demonstration of PHIBCB capability, all assets will be drawn from the PHIBCB Table of Allowance (TOA). The basic requirements are:

- 2 each SLWTs with crew
- 3 each intermediate causeway sections. The sections should be checked for proper fit of end connectors and guillotines.
- 4 each 18-inch snatch blocks with connecting hardware
- 2 pair 55-foot long 1-inch wire bridle legs with soft eyes (one operational set and one spare set)
- 2 each messenger lines
- 4 each 5- to 6-foot pry bars

A full inventory of all equipment used will be taken and used to formulate a recommended equipment list.

## SCHEDULE

The entire demonstration should take no more than 12 to 15 hours (2 days) of operating time, but the operations will be at the mercy of the weather and the concurrent barrier tests. Ideally, a preliminary day will be spent in assuring that the equipment is properly staged and the sequence of events will be discussed with all parties. Once initial preparations have been completed, the goals are:

**Day One**

**Phase 1** - SLWT with one C/W in tow will proceed to an operational site in the vicinity of NAB. SLWT 2 will follow with one C/W in tow. The sections will be rigged according to NAVFAC P-401 and the crafts will position themselves to conduct that operation. In order to evaluate the operation, at least three sections should be connected together with this method. Minor adjustments in the rig may be made, but the craft positioning and basic layout should remain the same.

**Phase 2** - Reposition the SLWTs according to the revised arrangement. Repeat the series of connections under similar weather conditions to the Phase 1 tests.

**Day Two**

**Phase 3** - After agreement is reached on the most satisfactory rig for rough water connections, SLWT 1 with one C/W and SLWT 2 with two C/Ws will proceed to a less protected area in search of 3.5-foot waves. Local marine weather reports will be monitored and an instrumented buoy will be monitored for sea states. The availability of the desired wave height will determine if the trial is feasible. If no significant waves are available, then the crews may demonstrate normal unassisted connection methods. Weather reports for the following days will be monitored for suitability.

## Appendix B

## EVENT/TIME LOG
## 13-14 JANUARY 1994

The following times and action descriptions were taken from the log maintained during the Flexor marriage bridle tests conducted at PHIBCB-ONE during 13-14 January 1994.

> **NOTE**: The first test required PHIBCB-ONE personnel to rig sections in a manner similar to that called out in NAVFAC P-401. It was obvious they were not accustomed to such marriages as it took considerable time to "get going" with snatch blocks in place.

**Thursday, 13 January**

08:44:30 Began attachment of first snatch block to SLWT. Elapsed time to secure and decide position OK was 4 minutes.

08:47 Second snatch block carried from SLWT to causeway section. About 2 minutes required to pass cable under PH-10 padeye and secure turnbuckle to snatch block.

About 5 additional minutes required to carry third and fourth snatch blocks from SLWT and position near port and starboard Flexor channels.

After snatch blocks positioned, 6 minutes needed to pass the two 50-foot bridle lines through the two aft snatch blocks and connect to A-wire passed through forward snatch block. Crew had initial difficulty in knowing how to open and close snatch blocks for threading.

Once the lines were in place, crew noted that a problem would arise during marriage as there was insufficient distance between forward and rear snatch blocks to accommodate pulling in bridle lines all the way as required for connection. The forward snatch block was removed from PH-10 location and secured to PH-11 padeye located closer to forward end. Elapsed time to disconnect snatch block and reattach using available channel locks (crescent wrench located on other craft) was 10 minutes.

Additional 5 minutes used to pull bridle lines through the Flexor tunnels and secure to messenger lines.

Final preparations made to join second section. Wind cable pulled from drum, through block on SLWT and block on section, requiring 3 minutes. The two bridle lines were shackled to the A-wire (crew had trouble doing this without verbal assistance).

09:26 First and second messenger lines tossed to connecting causeway section.

09:27:30 Winch cable fed out as bridle cables pulled over to connecting section.

09:28:30 Shackles attached to Flexors for attachment of bridles.

09:30 Prybars used to extend connectors on connecting section halfway. One guillotine stuck and not falling into place. About 5 minutes of jockeying required to secure it.

09:40 Winch activated to draw sections together.

09:41 First guillotine on "live" section dropped into place.

09:43 Second guillotine dropped into place.

09:52 Sections unjoined and tug pulled away.

**NOTE**: The second test was used to evaluate "freestyle" marriage - that is, bump joining without the use of bridles. Both causeway sections lashed to SLWTs and moved together with Flexors extended halfway.

09:56 First attempt a failure.

09:58 Second attempt also no go.

09:59:30 Third attempt a success.

**NOTE**: The next test involved connecting a third RO/RO section to the two already joined together. This involved moving bridle gear aft to the newly joined section for setup.

10:00:30 Crew began to break down bridle gear for transfer to aft section. The two aft snatch blocks repositioned on second section; A-wire run backward and connected to bridles at the turnbuckle. Elapsed time = 5 minutes.

10:11 Third section on approach. Messenger lines tossed.

10:13 Turnbuckles attached to NL connectors.

10:14 SLWT untied from "dead" section.

10:16:30 Mating complete; guillotines dropped on "live" section.

**NOTE**: In the next test the bridle lines and messengers were stationed on the "dead" section. In this sequence, the "dead" section was towed behind as the SLWT and leading section headed to sea.

10:52 Messenger lines tossed from "dead" section; bridles pulled over to leading section and passed through the snatch blocks. Elapsed time = 3 minutes.

10:57 SLWT underway.

11:00:30 Crew began winching in "dead" section; missed first time.

11:01 Slack taken up again with success. Sections joined.

**NOTE**: Same test conducted but at greater tow speed to evaluate effect on stability of trailing section.

11:14 Underway again.

11:16 Winching in "dead" section as it weaves behind.

11:17 Two sections joined.

11:17:30 Both guillotines secured on leading section.

LUNCH BREAK

**NOTE**: Work resumes by towing two "dead" sections behind in order to see if there is less weather vane effect from the longer configuration.

13:40 SLWT approaching with two modules in tow.

13:42 First bridle run through snatch blocks and joined to A-wire.

13:45:30 Second bridle fed through block and secured.

13:46:30 Under tow with two sections trailing. Less skating from side to side, but tandem appears to follow at somewhat of an angle to forward motion of SLWT. At about 15-foot separation, slack develops in bridle on same side as SLWT.

13:52 An apparent mating, however, one of the guillotines did not fall straight down into slot, but rather tilted and became wedged in the groove. Crew was unable to free and seat it manually. Second SLWT came alongside and maneuvered the joint until guillotine finally secured. Elapsed time = 7 minutes.

**NOTE**: Another test to add third section to two already joined in place. Coxswain unable to turn SLWT for change of course with two sections joined. He requires the assistance of second SLWT to get turned around.

14:31 SLWT coming up behind with dead (third) section in tow.

14:34:30 Messenger lines tossed.

14:35:30 Bridles pulled through connector housing.

14:36 Bridles passed through snatch blocks.

14:36:30 Bridle wires toggled to A-wire.

14:38 Under tow (shackle on one connector not hanging free but is out of position by about 2 inches).

14:41 First attempt at mating. Sections pulled together, but no go. The cocked turnbuckle appeared to be binding somewhat. The section in tow released and then taken in again and successfully joined [14:42]. The guillotines set at 14:43.

END OF DAY'S EFFORT

**Friday, 14 January**

**NOTE**: We had hoped for bad weather to go outside in search for sea state 3. The water is calm and glassy however, so as a substitute to sea state 3 connections we plan to join sections with differing trim. To accomplish this, one of the sections is loaded at one end with a heavy 6,000-pound anchor and two smaller 3,000-pound anchors, resulting in about an 8-inch differential in freeboard.

09:37 Out to sea again. With assist from second tug stopped alongside the towing platform there was less sway in the sections. The sections of differing draft were pulled together successfully without any problems.