TECHNICAL report

USA-BRDEC-TR // 2513

Improved Ribbon Bridge (IRB) Prototype Transporter— Operational Test

by
Kent Mitchell

Report Date
May 1992

Distribution unlimited: approved for public release.

United States Army
Belvoir Research, Development and Engineering Center
Fort Belvoir, Virginia 22060-5606

Destroy this report when it is no longer needed.
Do not return it to the originator.

The citation in this report of trade names of commercially available products does not constitute official endorsement or approval of the use of such products.

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (*Leave blank*)	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	May 1992	Final December 1989 - June 1990

4. TITLE AND SUBTITLE
Improved Ribbon Bridge (IRB) Prototype Transporter—Operational Test (U)

5. FUNDING NUMBERS

6. AUTHOR(S)
Kent Mitchell

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Belvoir Research, Development & Engineering Center
ATTN: STRBE-JBS
Fort Belvoir, VA 22060-5606

8. PERFORMING ORGANIZATION REPORT NUMBER
2513

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES
POC: Mr. Kent Mitchell, 703/704-1460

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Distribution unlimited; approved for public release.

12b. DISTRIBUTION CODE

13. ABSTRACT (*Maximum 200 words*)

This report presents information on the test efforts and results of the Prototype Heavy Expanded Mobility Tactical Truck (HEMTT) as an Improved Ribbon Bridge (IRB) Transporter. An operational test was performed on the transporter to determine if it was capable of interfacing with the Ribbon Bridge equipment.

14. SUBJECT TERMS
Load Handling System (LHS)
Bridge Adapter Pallet (BAP)
HEMTT
Ramp bay
Interior bay
Flatrack

15. NUMBER OF PAGES
112

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	Unlimited

Report Number 2513

Improved Ribbon Bridge (IRB) Prototype Transporter—Operational Test

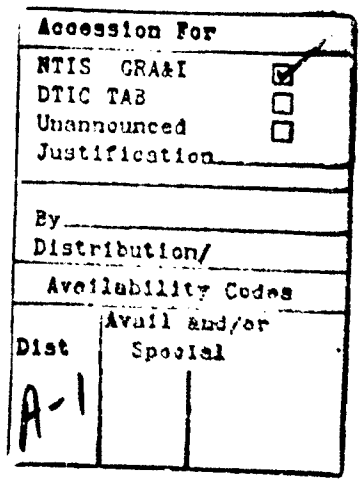
by
Kent Mitchell

US Army Belvoir RD&E Center
Fort Belvoir, Virginia 22060-5606

May 1992

Distribution unlimited; approved for public release.

Table of Contents



Preface

This project, conducted by the Bridge Support Team of the Combat Engineering Directorate, US Army Belvoir Research, Development and Engineering Center (BRDEC), was initiated to develop a prototype IRB Transporter utilizing equipment that was designed by Multilift for the Canadian Forces. The IRB Transporter consists of the following basic components:

- M-977 Heavy Expanded Mobility Tactical Truck (HEMTT) Chassis
- Multilift Load Handling System (LHS)
- Bridge Adapter Pallet (BAP)

The Transporter was assembled with the aid of the Model Fabrication Shop personnel and tested at BRDEC. The testing was conducted during the period of December 1989 through June 1990 under the supervision of the Support Bridging Team Leader.

Acknowledgements

Mark Levine, Mark Wilson, and Kent Mitchell were Belvoir RD&E Center engineers for the project. The following Bridge Division personnel assisted the project engineers and contributed to the system's testing:

John Short
Michael Bohlmann
SGT Arnold Lacour
Ernest T. Eschinger
SGT Dave Williams
SGT Dave Chubbs
Ray Balderson

Summary

This report presents information on the test efforts and results of the Prototype Heavy Expanded Mobility Tactical Truck (HEMTT) as an Improved Ribbon Bridge (IRB) Transporter. An operational test was performed on the transporter to determine if it was capable of interfacing with the Ribbon Bridge equipment.

A Load Handling System (LHS) was modified and mounted onto a HEMTT chassis at Belvoir Research, Development and Engineering Center. A Bridge Adapter Pallet (BAP) can be loaded onto the Transporter and enables the Transporter to carry the Ribbon Bridge. The Transporter also has the capability of launching, transporting, and retrieving 16-ton North Atlantic Treaty Organization (NATO) Standard Palletized Loading System (PLS) Flatracks.

The prototype IRB Transporter consists of an LHS mounted on an HEMTT. The Transporter retrieves a BAP which enables it to perform ribbon bridging operations. The Transporter tested at Belvoir was able to perform all operational and procedural tests attempted. Operations with the transporter in launching and retrieving fielded Ribbon Bridge bays and PLS Flatracks were conducted with little or no operational difficulty. The fit and function of the system did not degrade during the time of operation, although signs of wear were present.

Operational and design deficiencies were noted during the test, and modifications were made to eliminate some of the problems where possible. Lowering the BAP frame rails to provide clearance with the bay was the major change. The prototype Transporter tested had not been modified to interface with the Ribbon Bridge Erection Boat (RBEB) and Boat Cradle, and the Cargo Pallet. Future Transporters will be capable of transporting the fielded Ribbon Bridge bays, the PLS Flatrack, the RBEB and Cradle, fielded Cargo Pallet, and the IRB. A Contract Task Order (0015) has been issued to VSE (DAAK70-90-D-0001) to provide four future Transporters and BAPs which will accomplish all of these operations.

Addendum

Since testing was completed, numerous cycles with the Transporter have been completed for demonstrations and training purposes. There are still problems with the hydraulic system. Occasionally, the system tends to stay pressurized even after the PTO switch has been turned off. The switch must be turned on and off several times before the pressure can be relieved.

A failure occurred when the system was not properly prepared for launching. The BAP and bay were to be dropped off the truck and all of the latches had not been correctly engaged. Damage was sustained to the front BAP locks which required complete refabrication of one and welding to the other.

The system is not fail-safe and operators must be extremely alert. Inspections must be made to insure that all of the latches have been engaged/disengaged. No safeguards have been added to the system to prevent it from operating when it is not properly prepared which could lead to serious damage to the equipment. Color coding of latches could be beneficial as well as electronic sensors on latches that could monitor the latches' positions and determine whether or not the impending operation could be performed.

Section I
Background

REQUIREMENT

The US Army has a requirement for a wheeled vehicle to launch, transport, and retrieve the Ribbon Bridge system. Currently, this requirement is filled by the M-945 and M-812 5-ton trucks equipped with a Ribbon Bridge launching mechanism. The fielded Ribbon Bridge has a few deficiencies and an updated Qualitative Materiel Requirement (QMR), dated March 1985, was issued by the US Army Engineer School (USAES) for an Improved Ribbon Bridge (IRB). The fielded Transporter was authorized by wavier to carry the 6-ton bridge bay payload. However, the addition of bouyant material and the lengthening of the IRB ramp bay to 22 feet resulted in a payload requirement of 7 tons. Although a wavier existed allowing the 5-ton truck chassis to carry 6 tons, the wavier could not be extended to 7 tons. In 1986, a contract was awarded for the development of an IRB to meet the requirements stated in the QMR.

As a result of the overloading condition, the proposed fielding of Paletized Loading System (PLS) trucks, and subsequent displacement of Heavy Expanded Mobility Tactical Trucks (HEMTTs) by the Army, Deputy Chief of Staff for Operations and Plans (DCSOPS) determined that the displaced 10-ton HEMTT vehicles would be refurbished and utilized as the Transporter for the IRB.

The initial prototype IRB Transporter under development exhibited several technical problems and, due to funding constraints in 1989, this development effort was terminated. In mid-1989, CG LOG Center recommended that USAES and Developer consider the PLS concept for transporting bridging equipment, including Ribbon Bridge. Studies of this concept were underway at BRDEC. Multilift, Limited, in response to queries from BRDEC, presented their LHS/BAP concept and subsequently a prototype system was assembled. The alternative IRB Transporter utilizes a Government-owned HEMTT M-977 chassis, a Government-owned Multilift Load Handling System (LHS), and a Bridge Adapter Pallet (BAP) purchased from Multilift, Limited.

PROTOTYPE IRB TRANSPORTER

The prototype IRB Transporter was assembled at BRDEC and is based on the LHS/BAP developed by Multilift, Limited. The LHS used for the prototype was an early Multilift MK-IV, taken from a Government-owned test vehicle. This LHS had been utilized by the

Army to determine the effectiveness of the PLS concept and is functionally similar to the Oshkosh/Multilift LHS. The LHS and BAP were mounted with the aid of Multilift in BRDEC's model and fabrication facility. Multilift supplied technical information as well as interfacing hardware. The Canadian Army purchased the PLS Trucks with the MK-IV LHS from PACCAR that the US Army leased to evaluate the PLS concept. The BAP was developed by Multilift for the Canadian Army for use with their ribbon bridging program.

IRB TRANSPORTER PERFORMANCE

The performance of the IRB Transporter is expected to meet or exceed that of the current 5-ton Ribbon Bridge Transporter. Along with the added capability of retrieving and deploying North Atlantic Treaty Organization (NATO) Standard PLS Flatracks, launch and retrieval times with the IRB Transporter should improve. The prototype system has not, however, been configured to operate with the boat cradle/bridge erection boat and the 5-ton Ribbon Bridge cargo pallet. These changes will be designed, installed, and tested during technical and operational testing. A contract for improvements in the launcher and BAP has been awarded and will be installed on units for the future technical and operational tests.

The testing and scope of this project were to determine the operational feasibility of the LHS/BAP equipment mounted upon the HEMTT vehicle in bridging operations (i.e., deploying, transporting, and retrieving bridge bays).

Section II
Investigation/Summary

DESCRIPTION OF MATERIEL

The IRB Transporter consists of three distinct components:

- M-977 HEMTT Chassis with self-recovery winch (photo 1, Appendix A).
- Prototype Multilift MK-IV LHS (photo 2).
- Prototype Multilift BAP (photo 3).

The MK-IV LHS was mounted on the HEMTT by the use of mounting brackets and associated hardware supplied by Multilift, Limited (photos 4, 5, and 6).

The MK-IV LHS necessitated minor modifications to the HEMTT. The drilling of mounting holes for attachment brackets, grinding, retapping, and relocating of mounting points was required to allow clearances around the battery box, fuel tank straps, and rear-reeve self-recovery winch guides (photos 7 and 8). None of the equipment integral to the M-977 was removed with the exception of a Gerry-can holder on the left rear side of the vehicle. The Gerry-can intefered with the rear mounting bracket on the LHS and was not remounted on the truck for testing.

The MK-IV LHS required significant modifications (photos 9, 10, 11, and 12). The middle frame of the LHS arm was truncated to provide clearance around the transfer case. The front cross member of the LHS compression frame was notched to clear the transfer case. Placement of the hydraulic lines, hydraulic controls, cabinet mountings, and other less significant changes were also made to the system.

The LHS was connected to the HEMTT hydraulically utilizing the auxiliary line from the power take off (PTO) and could be manually switched from the auxiliary to the winch position so that the winch is operational. Hydraulic lines, required to operate the BAP winch, were routed from the LHS electrical control unit, along the length of the LHS frame, and back along the middle frame to the hook arm (photos 13 and 14). Quick disconnects are located on the hook arm so that the BAP can quickly hook up to the Transporter and become operational. Electrically, the system was wired into the PTO switch in the cab. The electromechanical components of the LHS/BAP are activated whenever the PTO switch receives power. A switch to activate the Transporter's high idle control (@ 1,500 rpm) was also wired into the PTO switch and can be manually activated whenever the PTO is engaged.

The MK-IV LHS can be operated from two locations on the Transporter. A cab-mounted control box was added to the center console inside the cab (photo 15). The joystick activates the system to load or unload, and the selector switch allows the operator to choose the function. Position 2 moves the hook arm, position 3 operates the middle frame, and position 1 maneuvers the hook arm and middle frame automatically. When operated in the automatic mode, the hook arm will fully deploy, followed by the middle frame. This allows the driver to retrieve or deploy the LS Flatrack or the BAP without leaving the cab. A remote control box, with approximately 20 feet of cable, was installed on top of the driver's side storage box (photo 16). The remote control can be removed from the storage box and has three switches. The winch, middle frame, or the hook arm can be operated by turning the selector switches right or left, thus allowing the LHS to perform any task that is needed. The remote control is the only location where the winch can be operated from. For safety, a rudimentary platform was placed behind the engine (over the transmission) in front of the LHS system (photo 17). The platform enables an operator to stand while connecting hydraulic lines and throwing the the winch frame locking levers (photo 18).

The BAP was modified in several ways (photos 19, 20, and 21). Attachment hooks for the front stays of the BAP were added to the MK-IV so that the BAP could lock down to the LHS mechanism. A storage container was removed on the driver's side of the BAP so that there was no inteference with the LHS system. Two rungs of a ladder also had to be removed in this area due to the inteference. Additionally, the BAP front frame rail required modification to eliminate inteference with US Ribbon Bridge ramp bays.

SCOPE

The tests described below were performed by BRDEC personnel at Belvoir's facilities. The testing was conducted to determine:

- The functional adequacy and operational effectiveness of the BAP as a device to enable the Multilift LHS system to perform Ribbon Bridge operations.
- The adequacy and operability of the interface of the LHS/BAP to the HEMTT.
- The ability of the Transporter to perform all operations necessary with a NATO Standard PLS Flatrack.
- To discover and identify any shortcomings, interferences, operational difficulties, system inadequacies, etc., while in operation.

TEST OBJECTIVES

- Determine the functional adequacy of the IRB Transporter to efficiently perform the dual role of operations as a Ribbon Bridge Transporter and a PLS truck.
- Verify that the interface between the M-977 HEMTT Chassis and the LHS system is functionally adequate.
- Identify operational and procedural shortcomings and inadequacies with the LHS/BAP in operation mounted upon the HEMTT Chassis.
- Identify operational and procedural shortcomings and inadequacies with the IRB Transporter when used to launch and retrieve the fielded Ribbon Bridge.
- Provide data for refining or improving the LHS and the BAP in its operation as an IRB Transporter.

TEST RESULTS

The IRB Transporter was able to perform all operational and procedural tests attempted. Operations with the system in launching/retrieving fielded Ribbon Bridge bays were conducted with little or no difficulty. The fit and function of the system did not degrade during the time of the operation and testing, although signs of wear were present on the BAP where the bay came in contact with wear pads. Additionally, the overloading condition of the M-812 and M-945 Transporters was not present with the use of this system. The HEMTT, when loaded with the LHS, BAP, and either bay, does not exceed the gross vehicle weight rating as shown in the table below.

TRANSPORTER WEIGHTS

HEMTT Gross Vehicle Weights	**HEMTT Chassis**
Front Tandem — 30,000 lb	Front Tandem — 21,000 lb
Rear Tandem — 32,000 lb	Rear Tandem — 9,600 lb
Total Weight — 62,000 lb	Total Weight — 30,600 lb
HEMTT with LHS	**HEMTT with LHS/BAP**
Front Tandem — 22,720 lb	Front Tandem — 24,020 lb
Rear Tandem — 12,200 lb	Rear Tandem — 15,120 lb
Total Weight — 34,920 lb	Total Weight — 39,140 lb
HEMTT with LHS/BAP/Ramp Bay	**HEMTT with LHS/BAP/Interior Bay**
Front Tandem — 24,600 lb	Front Tandem — 22,520 lb
Rear Tandem — 26,200 lb	Rear Tandem — 28,940 lb
Total Weight — 50,800 lb	Total Weight — 51,460 lb

Documented test results are included as Appendix B.

The following minor shortcomings with the system were noted:

- Poor operation of the winch cable tensioner.
- The hydraulic quick disconnect couplings between the BAP and LHS were difficult to connect.
- Interference preventing the engagement of the roadway-roadway latch when a bay is locked down on the BAP (photo 22).
- Mirrors are essential due to the lack of rear visibility.
- Lack of catwalks on the BAP/LHS restrict access to the rear of the vehicle when in the water.
- The overall height of the system is above the 4 meter height requirement.
- Difficult to retrieve bays in fast water. The bays would turn perpendicular to the rear of the BAP and the lockdown pins on the bridge bay would "hang up" under the rear corner of the BAP.
- The ramp bay does not rest on the roller-guides at the rear of the BAP when fully retrieved (photo 23) due to the center roller on the BAP.
- The lengths of winch cable and remote control cable are not as long as desired.

PLS Flatrack Launch/Retrieval Tests

Testing with the PLS Flatrack was carried out with either one or two crewmen. The system was operated using both the cab controls, with one crewmember, and the remote control box, using two crewmen. Operations were sufficient with one person (photos 24, 25, and 26). The Flatrack can be picked up from angles varying up to 10 degrees with no difficulty. Vision, when backing to the Flatrack, was impaired by the electrical control unit on the LHS. However, once the hookeye on the LHS arm was engaged in the empty Flatrack, it could be retrieved in 45 seconds when the system was operating at high idle.

There were no difficulties encountered during testing with the exception that occasionally the Flatrack did not properly lock down. If the system was operated at idle speed, in the automatic mode, the pallet did not lock down in the rear. An electronic sensor (photo 27), which activates the hook arm, allows the hook arm to retract before the middle frame has completely retracted. As long

as the Flatrack is retrieved at high idle or is operated from the remote control unit, the Transporter loads and locks down the Flatrack properly.

Empty and Laden BAP Launch and Retrieval Tests

The IRB Transporter retrieved the BAP at angles up to 10 degrees (photos 28, 30, and 32). Once on the truck, hydraulic lines were connected and the winch frame lever arms were thrown to allow the winch frame to become a part of the hook arm (photo 34). Sometimes there was difficulty in connecting the hydraulic quick disconnects; however, this was often overcome by engaging and disengaging the PTO switch to help relieve the pressure in the hydraulic lines.

When the BAP was loaded with a ramp (photos 29, 31, and 33) or an interior bay, operations were also satisfactory. The system was operated from the cab controls and the remote control unit outside the truck without incident. The overhang of the interior bay off of the BAP did not cause a reduction of visibility or any malfunction (photo 35) when operating the system or driving. When connecting the hydraulic lines and engaging the lever arms, it was important to payout the winch cable, after the hydraulic lines had been connected, so that there was no tension on the cable. Tension made it impossible to engage/disengage the lever arms.

Retrieval of a BAP from the ground, loaded or unloaded, was accomplished in 45 seconds. Connection of the hydraulics and engaging the lever arms and locking pins can be done in under 2 minutes. Unloading the empty BAP or the BAP loaded with a bay can be completely accomplished in 2 minutes. Operations can be completed by one person; however, for expedient operations, a crew of two is recommended when using the BAP.

Deploy/Retrieval Bridge Bay Tests to Ground

When loading or unloading the Ribbon Bridge bays (photos 36 and 37), it was important not to extend the hook arm beyond the 8 inches prescribed in the manual (photo 38). If the hook arm was extended too far, the bay came in contact with the rear rollers (photo 39). This was more evident on the ramp bay than the interior, but was corrected by retracting the hook arm until the front of the bay cleared the rear rollers of the BAP.

If a lockdown pin becomes tight against the lockdown assembly (photo 40), the winch can pull the bay forward or the hook arm can lift the bay up to free the pin from the lockdown.

Operations were completed with two crewmembers; however, it is possible for one. To do this, the remote control unit was taken into

the cab after the winch cable was hooked to the bay. This allowed the operator to have a winch control in the cab. For safety reasons, this is not a recommended practice because the operator has limited visibility to the rear and cannot pay proper attention to the surroundings. The LHS should be operated by a crewmember from the remote control unit standing off to the side of the Transporter. The other crewmember should be driving the Transporter and manuevering it under the bay. Operations of loading or unloading could be completed in less than 2 minutes.

Controlled Launch Test

The controlled launch of the interior and ramp bays to the water was completed without incident (photos 41, 42, and 43). This test was similar to launching the bays to the ground and the amount of time needed to complete the operation was approximately 2 minutes.

There were several instances during a controlled launch where a problem could occur. If the bay turned sideways in the water and the lockdown pin got caught on the rear of the BAP, the hook arm would try to lift the bay, which could damage the bay and the BAP (photo 44). Additionally, during unloading in fast water, the bay tends to turn sideways faster than it advances out. This will also cause the bay to hang up on the rear of the BAP. Finally, the length of hook arm deployed (8 inches recommended in the operator's manual) is crucial to the clearance of the front of the bay over the rear cross member of the BAP.

During this test, it was determined that catwalks would be beneficial for the Transporter. If the bay was to hang up on the rear of the BAP or the lockdown assemblies had to be adjusted, it would be difficult and unsafe to gain access to the rear of the truck while in the water.

It is recommended to have a crew of two for a controlled launch operation. A vehicle operator is needed to back the truck into the water. The second crewman would operate the LHS using the remote controls from the bank.

Free-Launch Test

Free-launching the ramp and interior bays was accompilshed with little trouble during the trials (photos 45, 46, and 47). The outer-front resting pads on the BAP exhibited some wear due to the free-launching, but did not seem to affect operations (photo 48). The use of rollers instead of wear pads would improve launching if rollers were designed and incorporated. The lanyard required a greater effort to release during testing; however, this was due to the lanyard mechanism. After adjustment, the lanyard release was improved.

In order to disengage the front roadway-to-roadway latch, the bay had to be control-launched approximately 8 inches so the latch could be disengaged. This was due to a stop block located on the winch frame of the BAP (photo 22). Due to its position, there was insufficient space to throw this latch. After throwing the latch, the bay was returned and free-launch preparations were completed.

The ramp bay often required a higher launching angle, due to the location of the center of gravity, than the interior bay. Some deformation was evident on the front center "slide" pad (photo 49) on the BAP where it met the bays, but this minor occurrence did not affect the operations.

When retrieval of the bay was attempted in fast water, the bay turned perpendicular to the truck and the lockdown pin on the bay hung up on the rear of the BAP (photo 44). Retrieval without inteference would not have been possible without the aid of a boat.

Preparation and launch of the bay could be completed in under 4 minutes. Once the hook was attached to the bay, the bay could be retrieved onto the truck in 1 minute. Launching the bay could be done by one person and retrieval was best performed with two crewmembers.

High Bank Launch Test

The interior and ramp bays were lifted using the standard Ribbon Bridge lifting sling (NSN 3940-00-214-7493) without difficulty. However, due to the length of the current sling and the lower lifting height of this Transporter, as compared with the M-945, the bay rested against the rear of the BAP when it was lifted off the ground (photos 50, 51, and 52). This caused the paint to be scraped off of the bay; however, there was no damage to the aluminum skin. The design on the rear of the BAP allows the bay to have metal-on-metal contact instead of the bay resting on the rear bumper of the BAP. The interior bay was slung in two different manners (photos 53 and 54). The first time, the sling was set up using uneven cable lengths with the longer cable hooked to the rear of the bay. This picked up the bay satisfactorily and the bay was level. The second time the bay was picked up, the sling had all four cable lengths equal (as is done with the current Transporters). When this setup was used, the bay was not picked up level and the setup did not work as well. Further analysis must be done to improve the slinging arrangment of the bays.

One other problem noted during the high bank launch was with the snatch block. Once, the winch cable was brought in too far and the hook assembly damaged the wheel on the snatch block (photo 55). Although the setup was still operational, a "caution" for this should be put in the manuals.

Section III
Test Details

INITIAL INSPECTION

Objective

The objective of the initial inspection is to take the HEMTT outfitted with the Multilift LHS unit, become familiar with its operation, and study its function as a Ribbon Bridge Transporter.

Criteria

In order for the Transporter to be a useful bridging truck, the following criteria must be met during the initial inspection:

1. The LHS mechanism must properly function in the automatic and manual modes. In the automatic mode, the system operates only from the cab. The hook arm fully extends, followed by the middle frame, until the arm has reached its desired height. In the manual mode, operations can be performed from the cab or the remote control unit. The controls are separate for the hook arm and the middle frame and are operated deploying the hook arm first. The manual mode allows the operator to control the amount that the cylinders are deployed.

2. The modified Transporter must operate mechanically in the same manner as it operated before the modifications were made.

Method

Before testing the Transporter with all of the bridging equipment, the truck will receive a general review. All fluid levels will be checked and filled accordingly. A drive around the facilities at the bridge hangar will be done to ensure that steering, brakes, and all pertinent equipment functions properly. Finally, the LHS will be cycled five times to verify that the individual components of the LHS system operate correctly in the automatic and manual modes.

Results

Motor oil was added to the engine and hydraulic fluid was added to the reservoir prior to testing. The fuel gauge had not been properly grounded after assembly and was not functioning. The fuel gauge ground wire was repaired and after driving the vehicle, it was apparent that the modifications had had no adverse effects on the truck's performance. The LHS was deployed and retrieved in the manual and automatic modes and no deficiencies were found.

Analysis

On the basis of the initial inspection, it was determined that the Transporter was in satisfactory condition and that testing with the bridging components could begin.

LAUNCH AND RETRIEVAL OF 16-TON STANDARD PLS FLATRACK

Objective

The objective of launch and retrieval cycles with the PLS Flatrack is to determine whether or not the adaption of the LHS to the HEMTT has affected the operational compatability of the two components.

Criteria

In order for the test to be successful, the following criteria must be met:

1. The LHS must deploy and retrieve the Flatrack without incident.

2. The system must complete ten cycles without failure.

3. The Transporter must be able to retrieve the Flatrack, with proper clearance, when it is on the ground at angles up to 10 degrees to the longitudinal centerline of the Transporter.

4. The system shall operate from the cab or the remote control unit.

Method

A cycle consists of one retrieval and deployment of an empty 16-ton standard Flatrack. The truck is backed up to the Flatrack and is stopped approximately 10 feet away. The PTO switch is engaged and the LHS is deployed using the automatic mode from the cab, or manually using the remote control unit. The hook arm is fully extended, followed by the middle frame, until the hookeye on the LHS arm is lower than the hook point on the Flatrack. The truck is then backed up so that the hook arm engages the Flatrack and the retrieval operation begins. Using the cab controls, the toggle switch is placed in the load position and the Flatrack is loaded. The operation can also be done manually using the hook arm and middle frame switches on the remote control. Once the Flatrack has secured itself onto the Transporter, the truck will be pulled forward and then brought back and deployed. The deploy cycle will be accomplished in the opposite procedure as the retrieval cycle.

During testing, the system will be operated at high idle (1,500 rpm) and low idle (600 rpm) and the number of personnel needed to successfully complete the mission will be determined. This will be

done to determine their effects on the deployment and retrieval operations.

Results

The Transporter successfully retrieved and deployed the Flatrack ten times without incident or failure. The Flatrack could be picked up from angles varying up to 10 degrees from parallel with no difficulty. Operations were carried out with either one or two personnel. When a single crewmember was used, all operations were completed using the controls in the cab. The system was also operated from the remote control box using two crewmembers and it was determined that operations were sufficient with one person. When backing up to the Flatrack with the Transporter, vision was impaired by the electrical control unit on the LHS. The use of side mirrors or the aid of a ground guide improved the hookup. Once the hookeye on the LHS arm was engaged in the Flatrack, the Flatrack could be picked up in 45 seconds when the Transporter was operating at high idle speed.

There were no problems encountered during testing with the exception that if the system was operated at idle speed, in the automatic mode, the Flatrack did not lock down in the rear. This was due to an electronic sensor located on the LHS. If the system is operated slowly, the middle frame will not fully retract before the hook arm starts to come in. This causes the rear of the Flatrack to not lock in place. The problem was corrected by operating the LHS at high idle or retrieving the middle frame manually before the hook arm was retracted.

Analysis

Based on the test results and the perfomance of the equipment, the Transporter satisfactorily launched and retrieved the PLS Flatrack. There were no major problems with the equipment during testing and all criteria were met.

LAUNCH AND RETRIEVAL OF EMPTY/LADEN BAP

Objective

The objective of the deploy and retrieval cycles of the empty or loaded BAP is to determine the compatibility of the LHS mechanism and the BAP, and review whether or not the combined system will properly withstand the operational test.

Criteria

In order for the following test to be acceptable, the following criteria must be met:

1. The LHS unit must be able to launch and retrieve the BAP for 20 cycles (ten empty, five loaded with the interior bay, and five loaded with the ramp bay) without failure.

2. The BAP must lock down onto the Transporter at all specified points (i.e., front frame locks and rear LHS/BAP hooks).

3. The winch frame levers shall engage to transfer the winch frame to the LHS, and hydraulic lines shall properly connect.

4. The Transporter must be able to retrieve the BAP with proper clearance when it is on the ground at angles up to 10 degrees from the longitudinal axis of the Transporter.

5. The system shall operate from either the cab controls or the remote control unit.

Method

Retrieve the BAP onto the Transporter in accordance with Chapter 1 of the operator's manual (Appendix C). Launch the BAP from the Transporter in accordance with Chapter 8 of the manual.

Results

The LHS system was operated a total of 20 times, ten cycles empty, five loaded with the ramp bay, and five with the interior. Once on the truck, the three hydraulic lines were connected and the lever arms on the winch frame engaged to transfer the winch frame to the LHS. Sometimes there was difficulty in connecting the hydraulic lines; however, this was often overcome by engaging and disengaging the PTO switch to help relieve the pressure in the lines. The Transporter had no problems picking up the BAP even at angles up to 10 degrees from parallel and the system could be operated from the cab controls or the remote control unit.

Whether the BAP was empty or loaded with a ramp or interior bay, operations were satisfactory. The four foot overhang of the interior bay off of the BAP did not present a problem to unloading or loading; however, after extended usage, this could cause the rear bay locks to require adjustment to fasten the BAP to the bay (photo 56). When connecting the hydraulic lines and throwing the lever arms, it was important to payout the winch so that there was no tension in the winch cable. Tension on the cable made it impossible to throw the lever arms.

Retrieval of a BAP, loaded or unloaded, could be accomplished in 45 seconds. Connection of the hydraulic lines and the rotation of the winch frame lever arms and locking pins could usually be done in under 2 minutes. Unloading the equipment could be completely accomplished in 2 minutes. Operations can be completed by one person; however, for expedient operations, a crew of two is recommended.

One additional point that was studied during testing was the effect on the BAP if the winch cable was or was not attached to the bay when the loaded BAP was retrieved or deployed. The winch cable was tested taunt, loose, and disconnected from the bay and its effects were reviewed. The system worked best when the winch was taunt because the bay added structural stability to the BAP. However, the system worked adequately when the bay was disconnected from the winch cable. This would allow the system to possibly be retrieved by a PLS truck in the future, which could then free-launch the bay without the use of the hydraulic winch.

Analysis

Testing and interfacing the BAP with the Transporter were completed without incident. The IRB Transporter satisfactorily retrieved and deployed the empty or laden BAP and all criteria tested for was met.

LAUNCH AND RETRIEVAL OF BRIDGE BAYS FROM GROUND

Objective

The objective of the following test is to study the operability of the HEMTT as a bridging Transporter. The Transporter has to be able to pick up interior and ramp bays onto the BAP without incident.

Criteria

In order for the system to be acceptable, the following criteria must be met:

1. The Transporter shall successfully complete ten cycles, five with the interior bay and five with the ramp bay.

2. The Transporter shall retrieve the bay from angles 10 degress from the longitudinal axis of the Transporter.

3. The system shall operate using either the controls in the cab (except for the winch) or the remote control box.

Method

Retrieval operations of a Ribbon Bridge bay from the ground are located in Chapter 2 of the operator's manual (Appendix C). In order to deploy the bay, see Chapter 3 and perform accordingly.

During testing, the system will be operated at low and high idle speeds with the number of personnel varied. Operations will be observed and deficiencies and problems will be recorded.

Results

The Transporter successfully loaded and unloaded the interior and ramp bays a total of ten times. The position between the centerlines of the truck and the bay could be offset up to $3^1/_2$ feet and the Transporter could manuever under the bay and load it. In addition, the system was operated from both the cab controls and the remote control unit with retrieval/deploy operations completed in less than 2 minutes.

When retrieving or deploying the bays from the Transporter, it was important to not extend the hook arm much beyond the 8 inches prescribed in the manual. If the hook arm was extended too far, the bay would come in contact with the rear rollers (photo 39). This was more evident on the ramp bay than the interior bay, but is corrected by bringing the hook arm "in" until the front of the bay has been elevated so that it will clear the rear beam of the BAP.

If a lockdown pin became tight against the lockdown assembly (photo 40), the winch could pull the bay forward or the hook arm could lift the bay up to free the pin from the lockdown.

Operations were completed with two crewmembers; however, it was possible for one. To do this, the remote control unit was taken into the cab after the winch cable had been hooked to the bay. This allowed the operator to have a winch control inside the cab. For safety reasons, this is not a recommended practice because the operator has limited visibility to the rear and cannot pay proper attention to the surroundings. The LHS should be operated by a crewmember from the remote control unit standing off to the side of the Transporter. The other crewmember should be driving the Transporter and manuevering it under the bay. Operations of loading or unloading could be completed in less than 2 minutes.

Analysis

The Transporter was able to launch and retrieve the bays successfully during testing. All criteria tested for was met and there were no major problems with the test. The bays locked down to the BAP and the system was ready to be tested in the water.

CONTROLLED LAUNCH OF BRIDGE BAYS INTO WATER

Objective

The objective of the following test is to determine if the Transporter can properly perform a controlled launch of the Ribbon Bridge bays to the water.

Criteria

In order for the controlled launch test to be successful, the following criteria must be met:

1. The Transporter shall complete ten cycles, five with the ramp bay and five with the interior bay.

2. The Transporter shall operate from the cab controls, except for the winch, and the remote control unit.

Method

Perform the controlled launch of a Ribbon Bridge bay in accordance with Chapter 5 of the operator's manual (Appendix C). Retrieval of the bay shall be performed in accordance with Chapter 6 of the operator's manual.

During testing, operate the system at high and normal idle speeds and vary the crew size to determine the effects on the mission.

Results

The controlled launch of the interior and ramp bays to the water was completed without incident (photos 41, 42, and 43). This test was similar to launching the bays to the ground and the amount of time needed to complete the operation was approximately 2 minutes.

There were several instances where a problem could occur during this procedure. If the bay turned sideways in the water and the lockdown pin got caught on the rear of the BAP, the hook arm would try to lift the bay. This could cause damage to the bay and the BAP (photo 44). Additionally, during unloading in fast water, the bay tends to turn sideways faster than it advances out. This will also cause the bay to hang up on the rear of the BAP. Finally, the amount the hook arm is deployed (8 inches recommended in the operator's manual) is crucial to the clearance of the front of the bay over the rear cross member of the BAP.

During this test, it was determined that catwalks would be beneficial for the Transporter. If the bay was to hang up on the rear of the BAP or the lockdown points had to be adjusted, it would be difficult and unsafe to get to the rear of the truck while in the water.

It is recommended to have a crew of two for a controlled launch operation. A vehicle operator is needed to back the truck into the water. The second crewmen would operate the LHS using the remote controls from the bank.

Analysis

The controlled launch test of the Ribbon Bridge Bays was acceptable and met all criteria that was prescribed. The Transporter had no trouble launching and retrieving the bays; however, no major tests were undertaken in fast water.

FREE-LAUNCH OF BRIDGE BAYS INTO WATER

Objective

The objective of the following test is to see whether or not the Transporter can effectively free-launch and retrieve a Ribbon Bridge bay to and from the water.

Criteria

In order for the free-launch test to be successful, the following criteria shall be met:

1. The Transporter shall complete ten cycles, five with the ramp bay and five with the interior bay.

2. The Transporter shall operate from the cab controls (except for the winch) and the remote control unit.

Method

Perform free-launch operations of the Ribbon Bridge bay in accordance with the procedures outlined in Chapter 4 of Operator's Manual (Appendix C). Retrieve the bay in accordance with Chapter 6 of the manual.

During testing, vary the idle speed (high and low idle) and the crew size to determine the optimum conditions for a mission.

Results

Free-launching the interior bay was accomplished with little trouble during the trials (photos 45, 46, and 47). The outer-front resting pads on the BAP exhibited some wear due to the free-launching, but did not seem to effect the operations (photo 48). The use of rollers instead of wear pads would help to improve launching if rollers were incorporated. A greater effort was required to pull the lanyard during testing; however, this was due to the lanyard mechanism. After adjustment, the lanyard release was improved.

In order to throw the front roadway-to-roadway latch, the bay had to be control-launched approximately 8 inches so that the latch could be engaged. This was due to a stop block that was located on the winch frame of the BAP (photo 22). Due to its position, there was insufficient room to engage this latch. After engaging the latch, the bay was brought back down and free-launch preparations were completed.

Free-launching the ramp bay was also successful. The ramp bay often required a higher launching angle than the interior bay due to the location of the center of gravity. Some deformation was evident on the front center "slide" pad (photo 49) on the BAP where it met the bays, but this was a minor occurrence that did not seem to affect the operations.

When retrieval of the bay was attempted in fast water, the bay turned perpendicular to the Transporter and the lockdown pin on the bay hung up on the rear of the BAP (photo 44). Retrieval without inteference would not have been possible without the aid of a boat.

Under normal circumstances, once the hook was attached to the bay, the bay could be retrieved onto the Transporter in 1 minute. Preparation and launch of the bay could be completed in under 4 minutes. Launching the bay could be done by one person and retrieval was best performed with two crewmembers.

Analysis

The Transporter sucessfully free-launched and retrieved interior and ramp bays from the water. Launching could be improved by the use of front rollers on the BAP, but testing went well overall.

HIGH BANK LAUNCH OF BRIDGE BAYS

Objective

The objective of the high bank launch is to determine whether or not the Transporter can effectively pick up and transport a Ribbon Bridge bay in the high bank configuration.

Criteria

In order for the following test to be successful, the Transporter shall launch and retrieve Ribbon Bridge interior and ramp bays from the high bank launch configuration. Crew size and procedural steps for launching will be reviewed.

Method

Perform the high bank launch in accordance with Chapter 10 of the Operator's Manual (Appendix C).

Results

The interior and the ramp bay were lifted using the standard Ribbon Bridge lifting sling (NSN 3940-00-214-7493) without difficulty. However, due to the length of the current sling and the lower lifting height of this Transporter, as compared with the M-945, the bay rested against the rear of the BAP when it was lifted off of the ground (photos 50, 51, and 52). This caused the paint to be scraped off of the bay; however, there was no damage to the aluminum skin. The design on the rear of the BAP allows the bay to have metal-on-metal contact instead of the bay resting on the rear bumper of the BAP. The interior bay was slung in two different manners (photos 53 and 54). The first time, the sling was set up using uneven cable lengths with the longer cable hooked to the rear of the bay. This picked up the bay satisfactorily and the bay was level. The second time the bay was picked up, the sling had all four cable lengths equal (as is done with the current Transporters). When this setup was used, the bay was not picked up level and the setup did not work as well. Further analysis must be done to improve the slinging arrangment of the bays.

One other problem noted during the high bank launch was with the snatch block. Once, the winch cable was brought in too far and the pulley on the snatch block (photo 55) was damaged. Although the system was still operational, a "caution" for this should be put in the manuals.

Analysis

The Transporter successfully retrieved and deployed the Ribbon Bridge bays into the water. The only concern was with the lifting sling which will have to be analyzed to see if an improved sling or procedure can be established for the high bank configuration.

Section IV
Conclusions

The Transporter that was modified and assembled at Fort Belvoir completed testing with little difficulty. There were only minor failures during its continued use, and most of those were related to the hydraulics.

Overall, there were a few operational and design problems that became apparent during testing. To remedy these problems, the following areas need to be reviewed by the designer for possible modifications which will improve the overall system:

- A high idle switch, which was added to our Transporter during testing by Belvoir personnel, alleviated the "jerky" motion of the LHS and improved operation times.

- A catwalk is needed to allow personnel to gain access to the rear of the Transporter when it is in the water. If the bay was to interfere with the BAP or a locking ear is not properly set, access to the bay is difficult.

- Increasing the length of the remote control cable to at least 30 feet would give the operator sufficient room for visibility and safety when the Transporter is in the water.

- The length of wire rope on the winch drum needs to be increased. Currently, there is no more than 25 feet of cable and at least 50 feet of wire rope on the drum is needed in order to retrieve the Ribbon Bridge erection boat and cradle assembly.

During testing with the PLS Flatrack, it was noted that the Flatrack would not properly lock down onto the Transporter if the LHS was operated at idle speed in the automatic mode. The cause was determined to be because a proximity switch on the LHS allowed the hook arm to begin retracting before the middle frame had completely retracted. This did not allow the rear of the Flatrack to fasten. Retrieving the Flatrack at high idle speed or bringing the LHS arms in manually eliminated this problem.

The ramp bay did not rest on the rear of the BAP. The bay rests on the rear center roller and, due to a metal-on-metal inteference, the roller was not low enough to allow the bows to come in contact with the BAP outer rollers (photo 23).

When free-launching the bays, there were several areas of concern:

- In order to disengage the front roadway-to-roadway latch, the bay had to be control-launched approximately 8 inches so that the latch could be disengaged. This was due to a stop block that was located on the winch frame of the BAP (photo 22). Due to its position, there was insufficient space to disengage this latch. After disengaging, the bay was brought back down and free-launch preparations were completed.

- The hook on the winch cable should be spring-loaded like the hook on the existing Transporter. Trying to use the cotter key that came on the system would be difficult in cold weather and the cotter key is easily damaged.

- The rear of the BAP should be redesigned to remove the opening where the bridge bays hang up (photo 57). As it is currently built, there is a gap between the plastic guard and the rear ground support. This is an area in which the bay lockdown pin can get caught if the bay is retrievd from the water when it is perpendicular to the Transporter.

- The hook arm has to be extended out further when the ramp bay is launched (8 to 10 inches) due to the center of gravity of the bay. If rollers were added to the middle supports, launching of the bays would improve and the wear pads on these supports would not become worn.

- The lanyard and pulling mechanism on the BAP was difficult to release for some of testing, but as the system was functioned more and more, operation improved.

Throughout testing, there were problems with the winch and its hydraulics.

- The hydraulic quick disconnects were difficult to hook up. Once the lines were uncoupled and the PTO switch was engaged, the lines would become pressurized and make connection impossible. By cycling the PTO switch on and off rapidly, the pressure was eliminated and the connection could be made. After testing, improved quick disconnect couplings were installed, alleviating most of the connection problems.

- Problems with the quick disconnects led to three separate hydraulic line failures. However, since the couplings were changed, no failures have occurred.

The first failure occurred when one of the hydraulic quick disconnects to the winch was not properly fastened. After the winch did not work, the idle was increased. The controls were operated, overpressurizing the main hydraulic line to the auxiliary switch, causing the line to rupture.

The two other incidents occurred when twice the case drain line on the winch ruptured. The case drain line overpressurized and caused the low pressure hose to rupture. All hydraulic line failures were attributed to the quick disconnects not properly connected by the operator. Operation of the system is detailed and proper procedures must be followed to insure safe operation.

Testing of the Transporter went very well. The system was able to interface with all of the equipment that was tested and perform all operations expected. Information was included that will help to improve and minimize deficiencies in the future Transporters.

Appendix A
Photographs

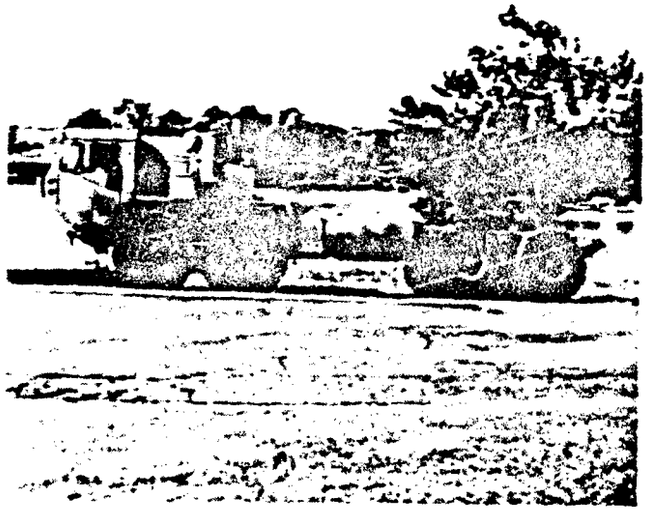


Photo 1. A standard M-977 HEMTT Chassis with self recovery winch

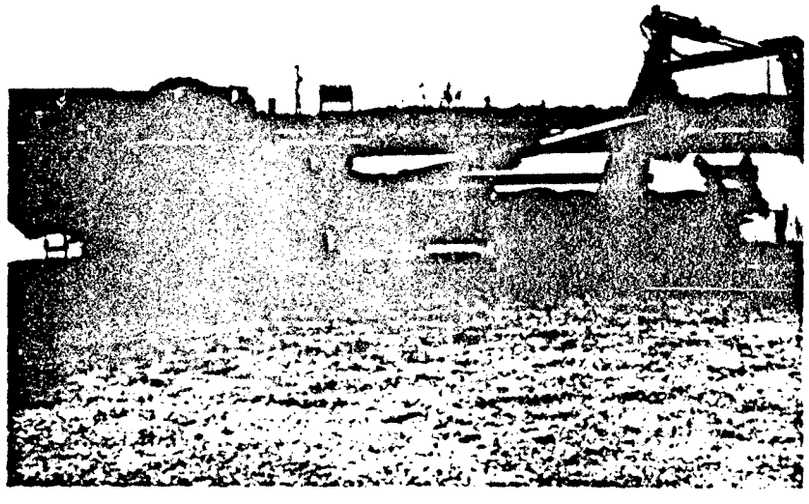


Photo 2. A prototype Multilift Mark IV LHS mounted on a M-977 HEMTT. The LHS is extended.

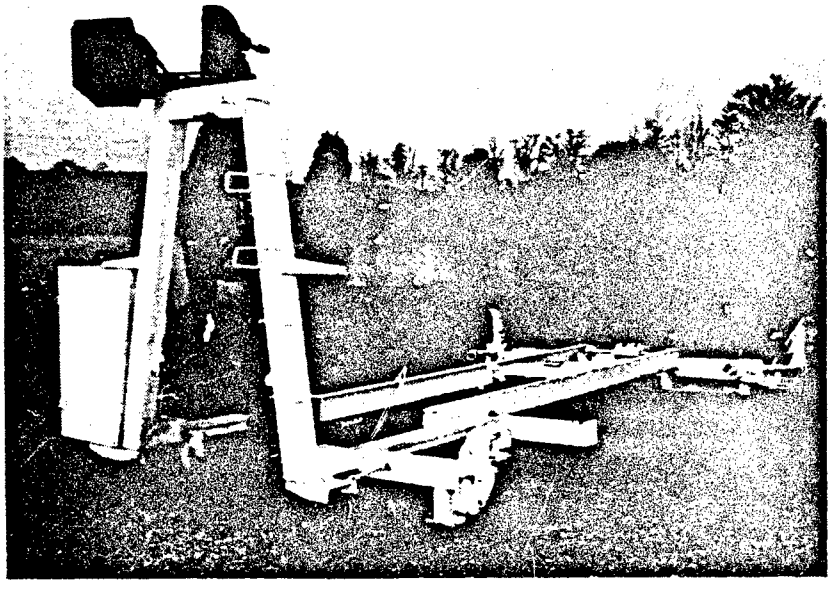


Photo 3. A prototype Multilift Bridge Adapter Pallet (BAP)

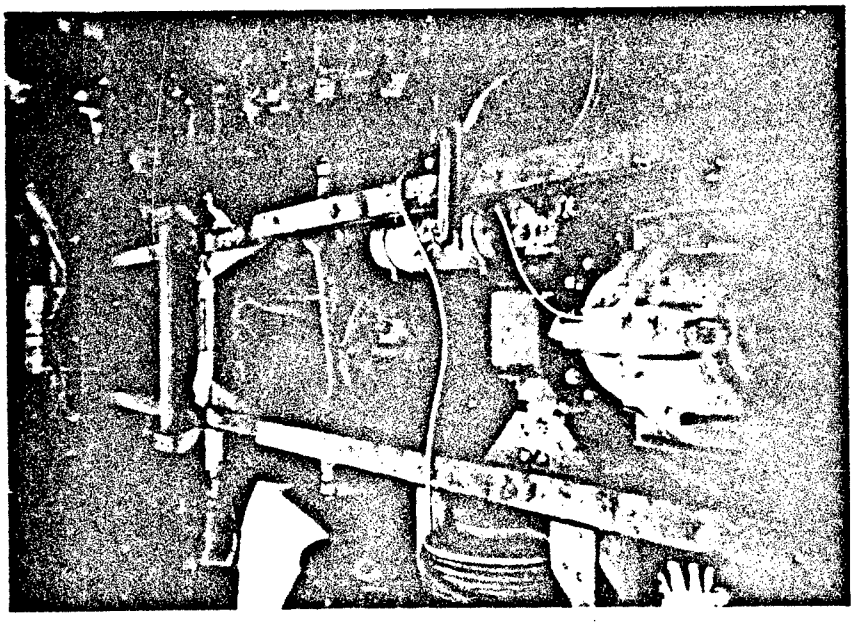


Photo 4. Brackets have been mounted onto the HEMTT so that the LHS will clear the differential

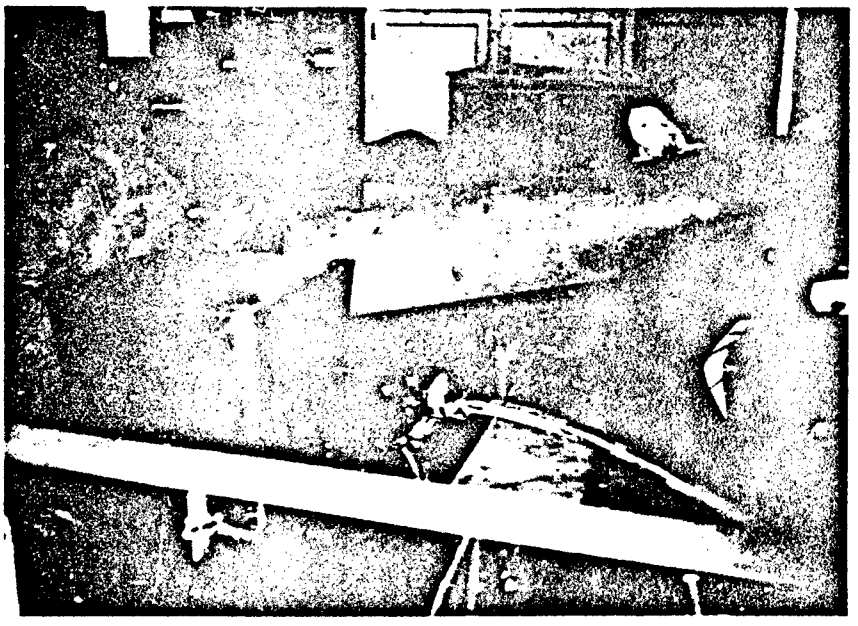


Photo 5. The front mounting bracket is assembled around the driveshaft and electrical line

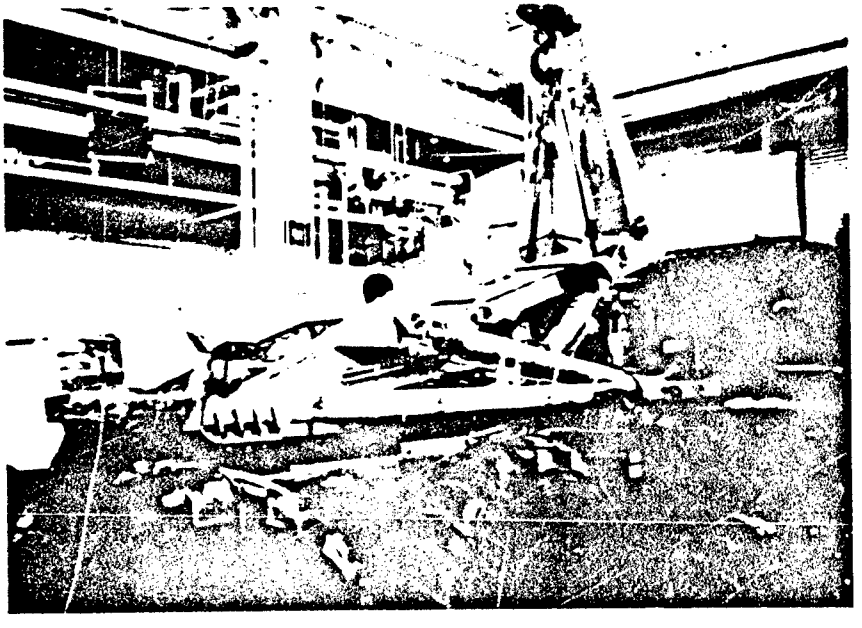


Photo 6. The LHS is lowered onto the HEMTT during modification

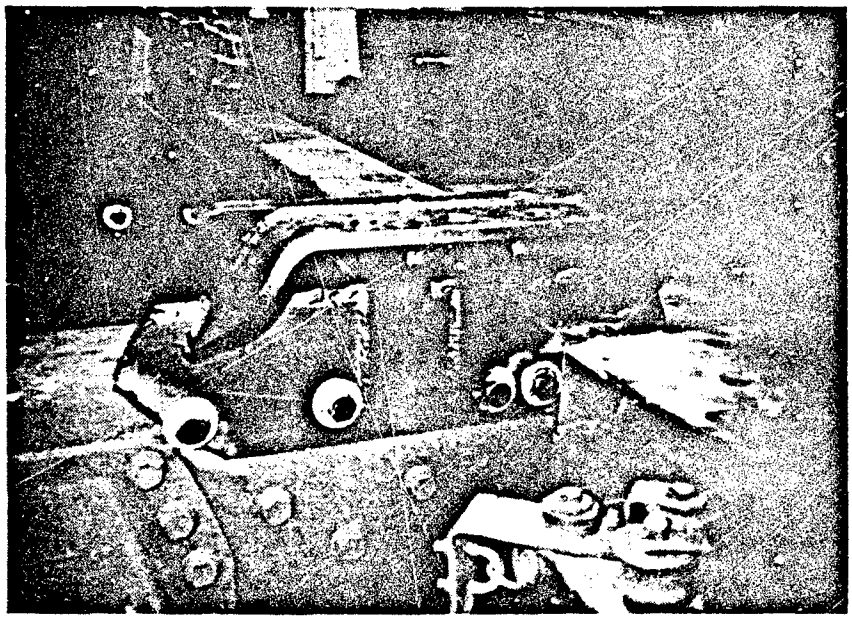


Photo 7. The rear mounting bracket of the LHS had to be cut so that the winch cable guide could be mounted

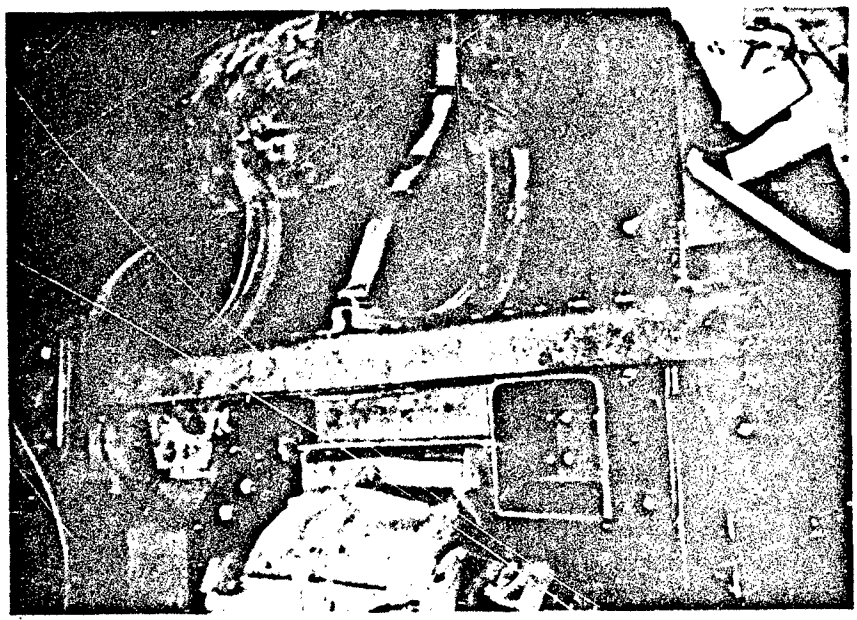


Photo 8. The fuel tank was removed so that the LHS mounting brackets could be bolted to the frame

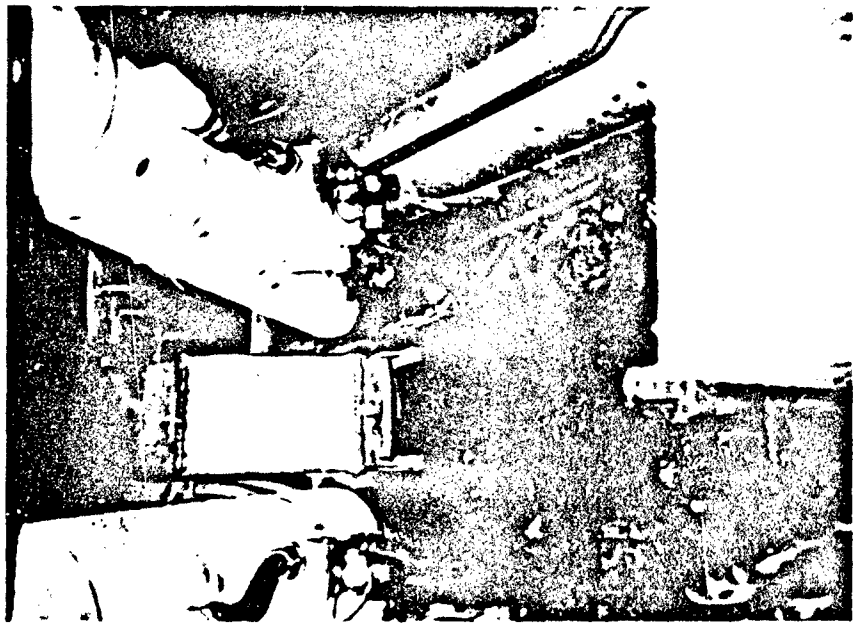


Photo 9. The middle frame of the LHS was truncated

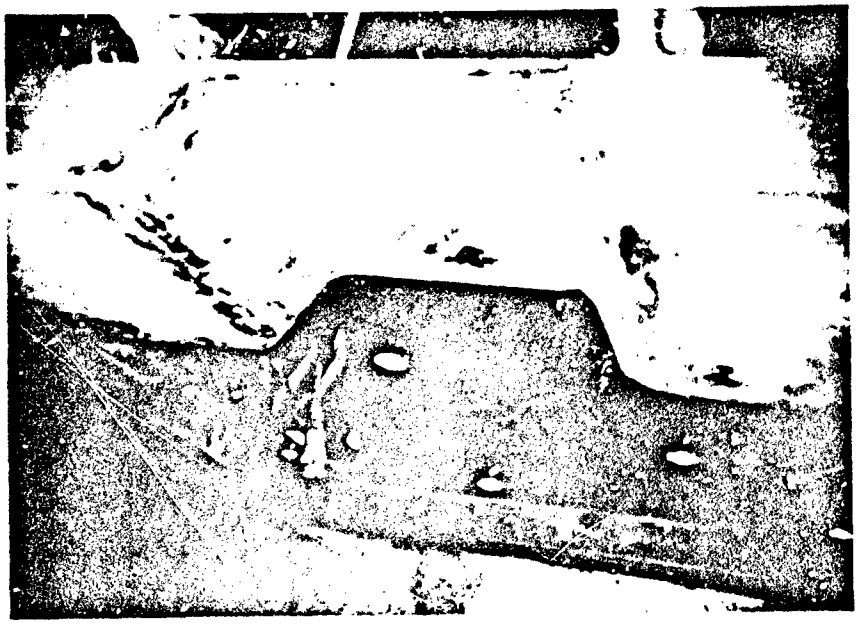


Photo 10. The front cross member of the LHS was notched to clear the transfer case

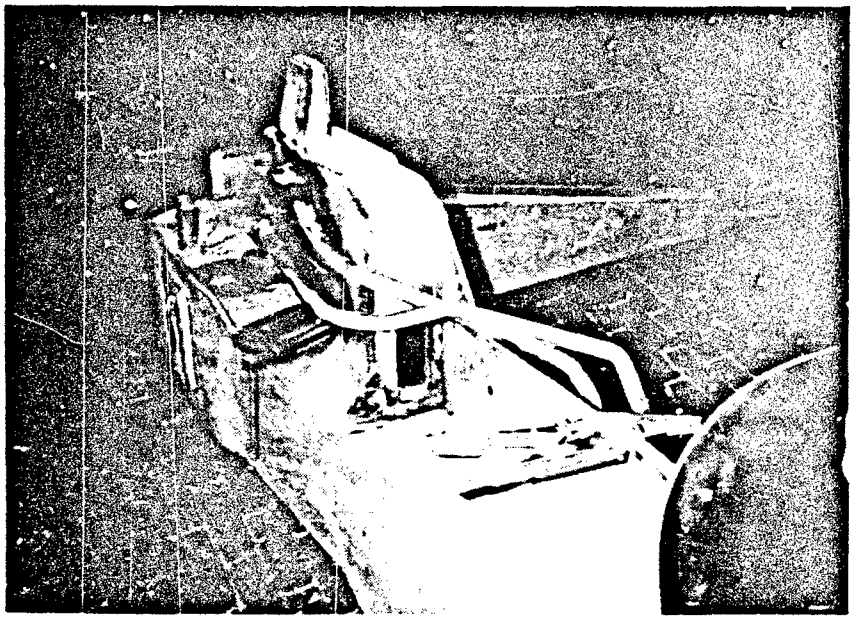


Photo 11. A passageway was cut in the hook arm to route hydraulic lines

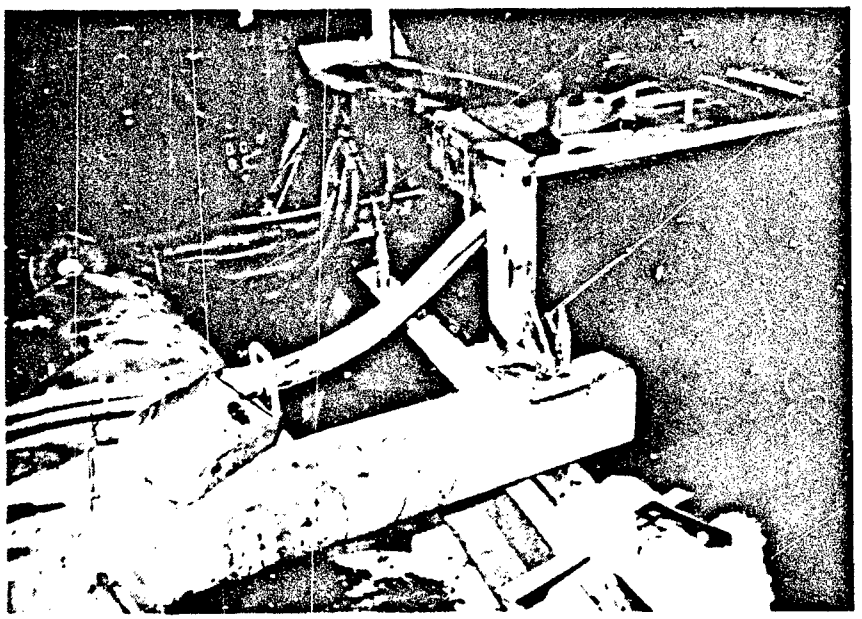


Photo 12. The hydraulic control box and mountings were moved 4 inches to the left and rewelded

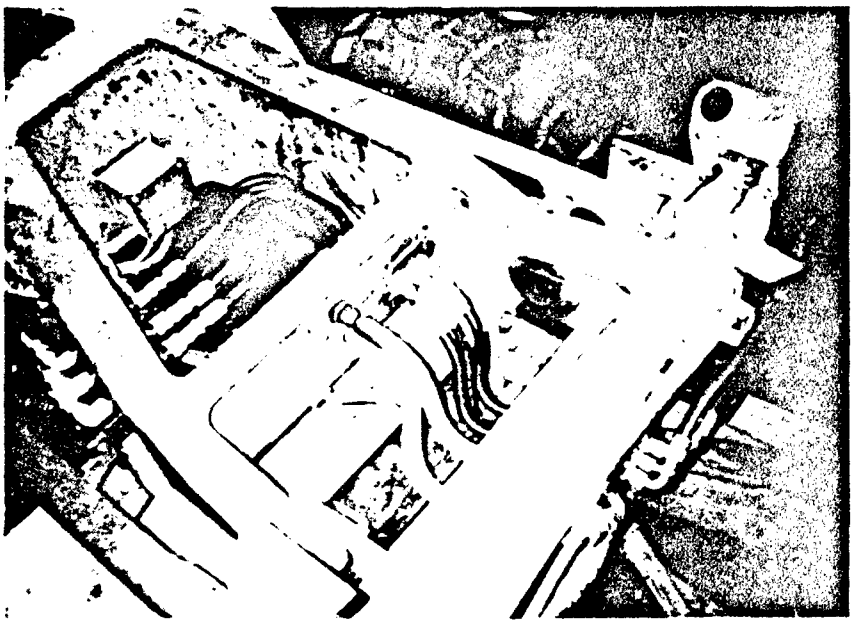


Photo 13. Hydraulic lines were mounted through the back of the LHS and through the middle frame

Photo 14. The hydraulic lines were mounted alongside the middle frame and the hook arm

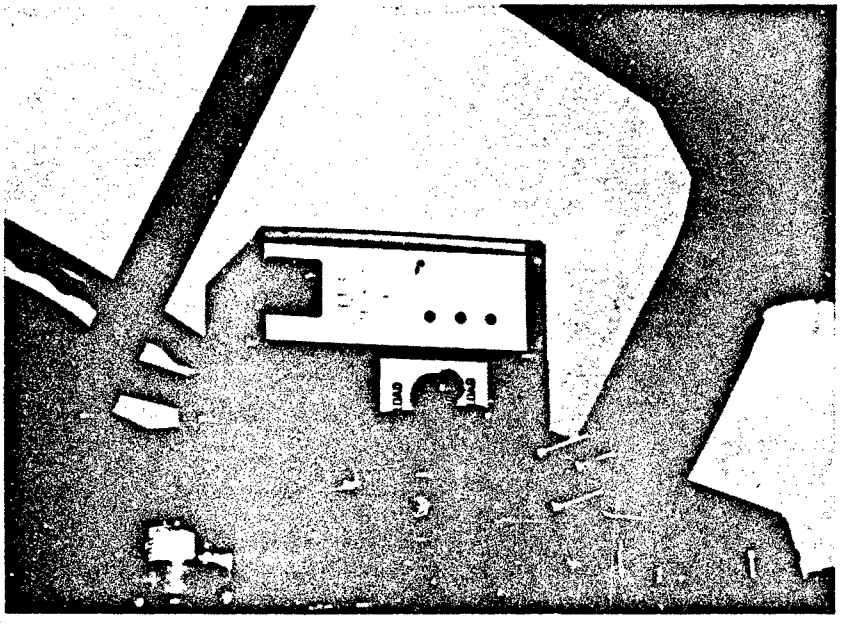


Photo 15. A cab mounted control box is located to the driver's right. The selector switch controls the operation.

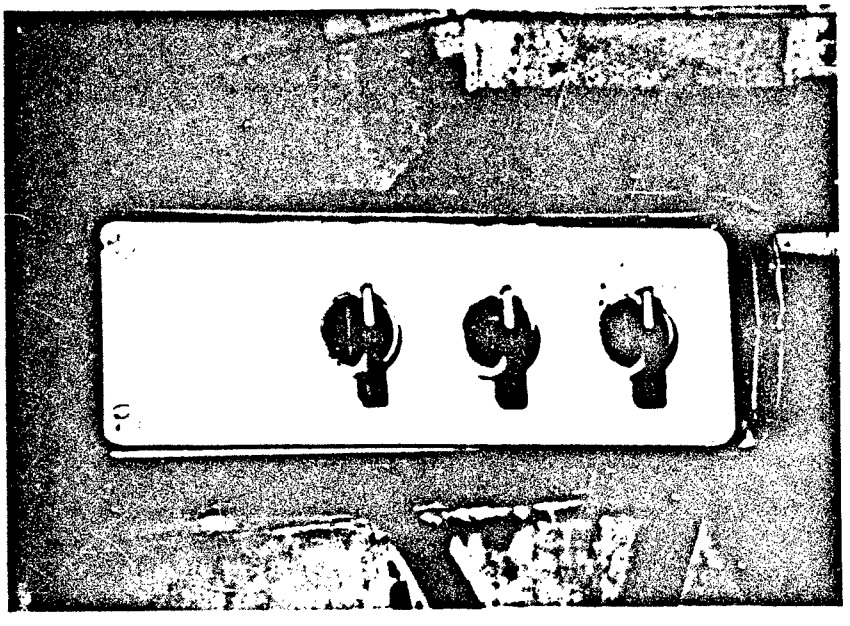


Photo 16. The remote control box has separate switches for the winch, hook arm, and middle frame

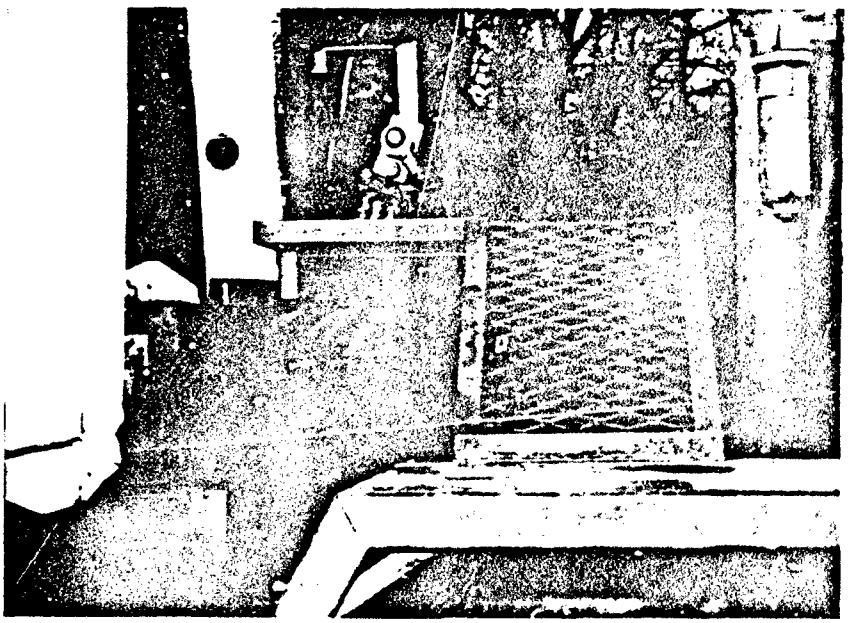


Photo 17. A platform was added over the transmission in front of the LHS

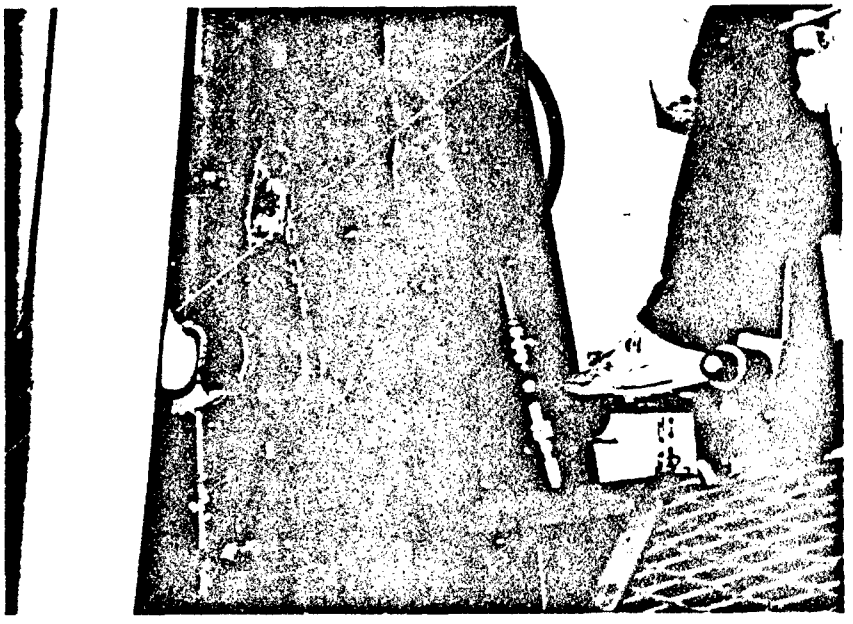


Photo 18. An operator can stand on the platform while throwing the winch frame levers and connecting hydraulic lines

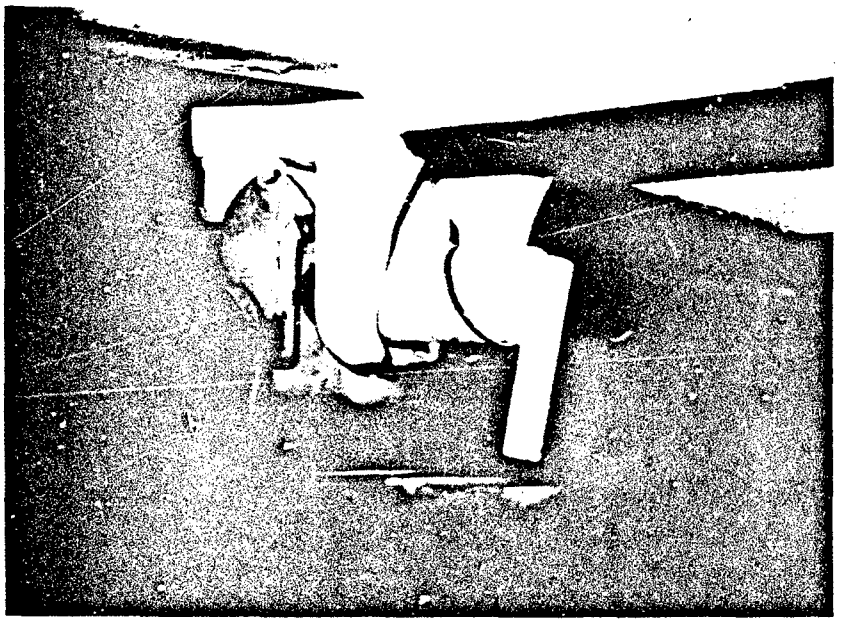


Photo 19. The front locks on the BAP attach to the LHS

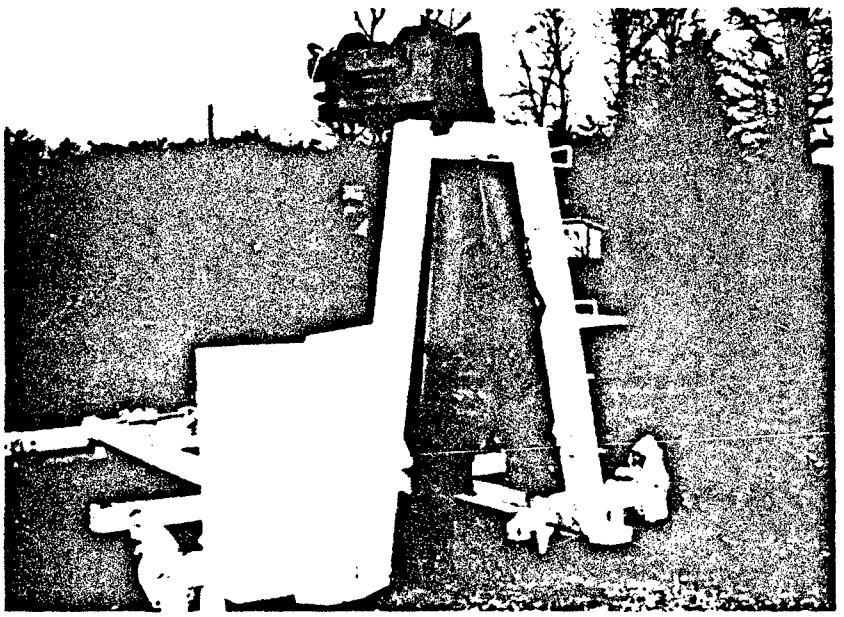


Photo 20. The two bottom rungs of the ladder and the left side storage box were removed due to inteference

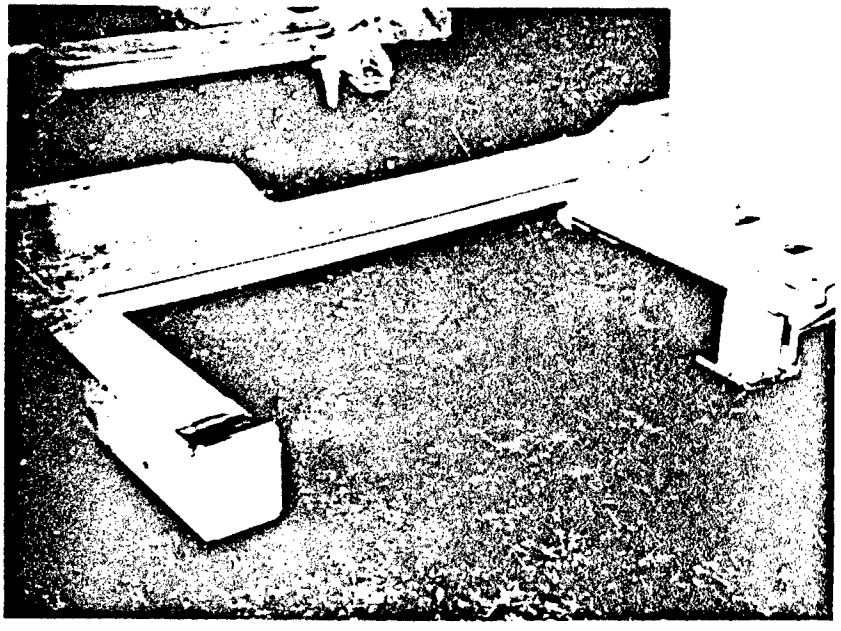


Photo 21. The front frame rails were cut and lowered to provide clearance with the lever arms (see Photo 22 for interference)

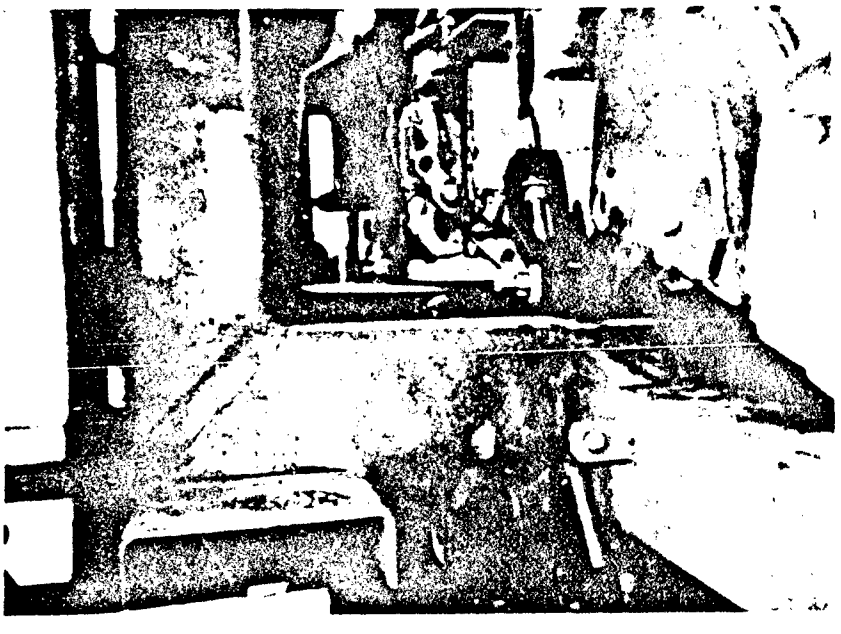


Photo 22. The roadway to roadway latch could not be thrown because it intefered with the stop block on the winch frame

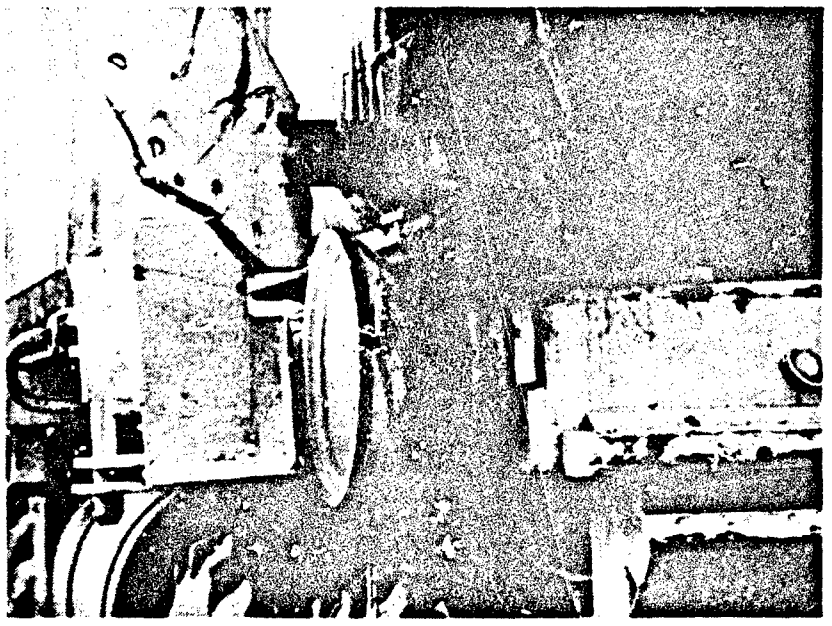


Photo 23. The ramp bay bow ponton did not rest on the rear roller

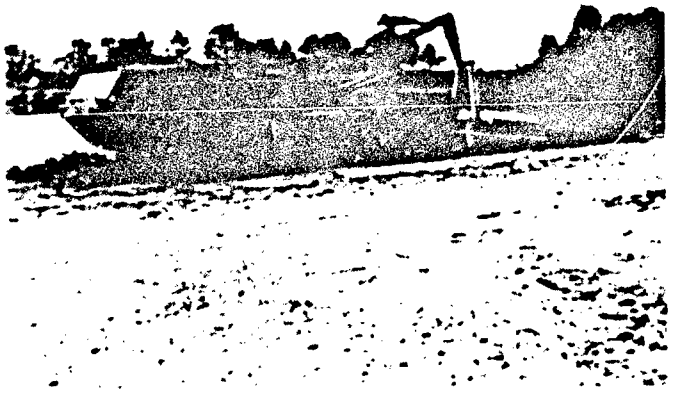


Photo 24. The Transporter begins to pick up the flatrack

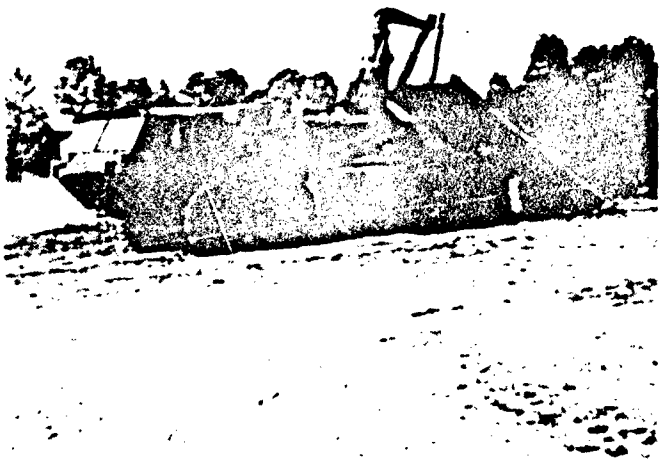


Photo 25. The Flatrack is loaded halfway onto the Transporter

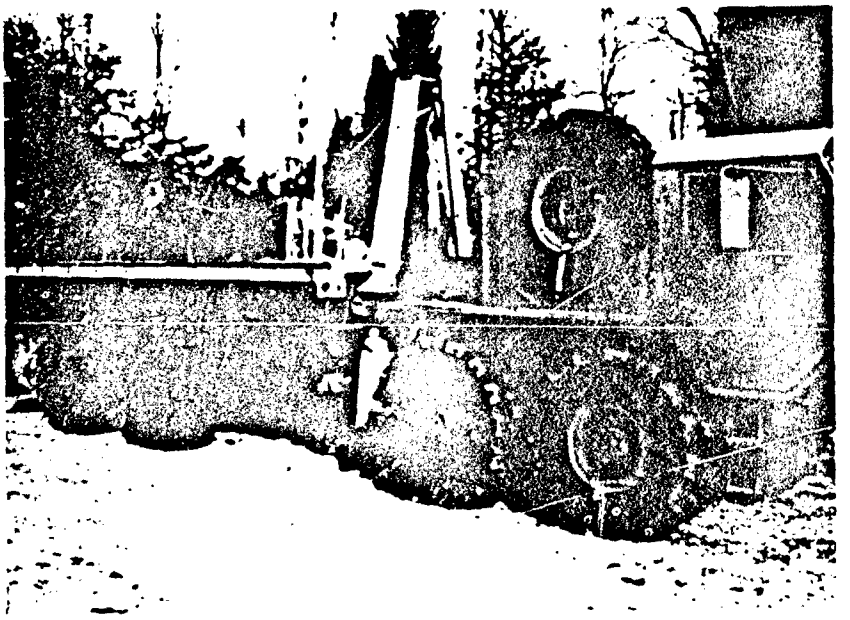


Photo 26. The Flatrack is locked down and ready for Transport

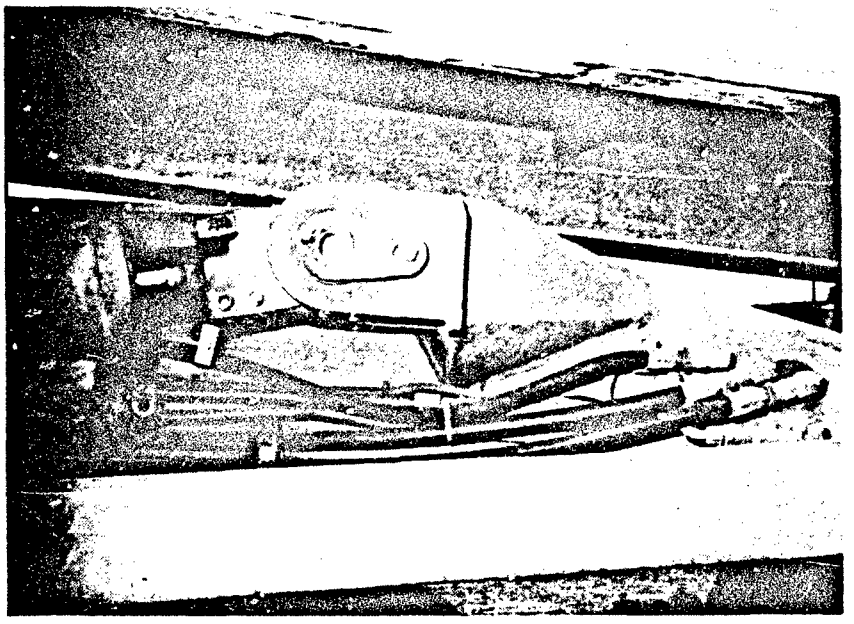


Photo 27. The electronic sensor has prevented the middle frame from fully retracting

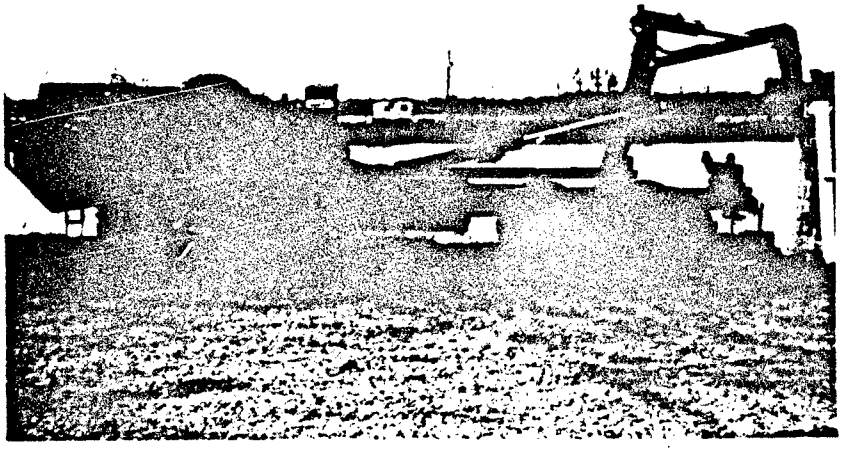


Photo 28. The Transporter begins to retrieve the BAP

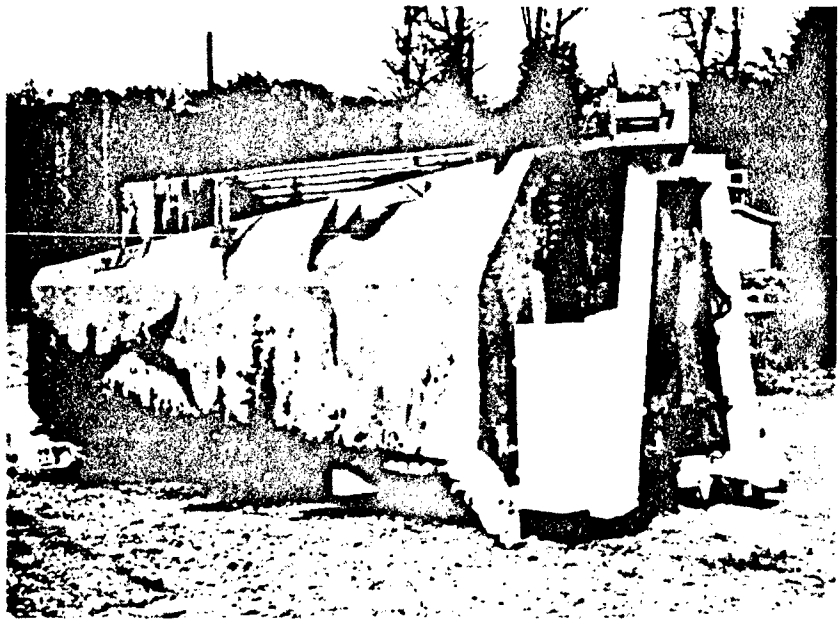


Photo 29. The BAP is preloaded with a ramp bay

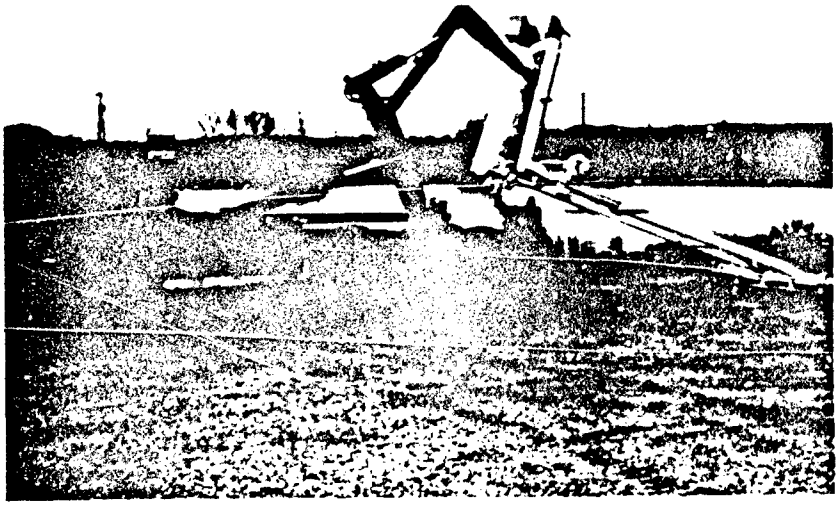


Photo 30. The BAP is lifted over the rear rollers

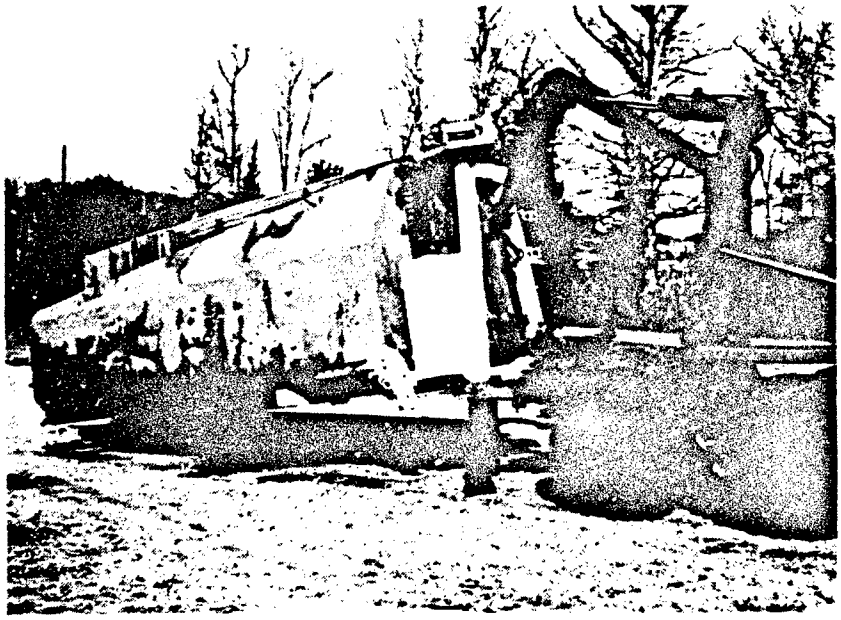


Photo 31. The BAP and bay are lifted off the ground by the Transporter

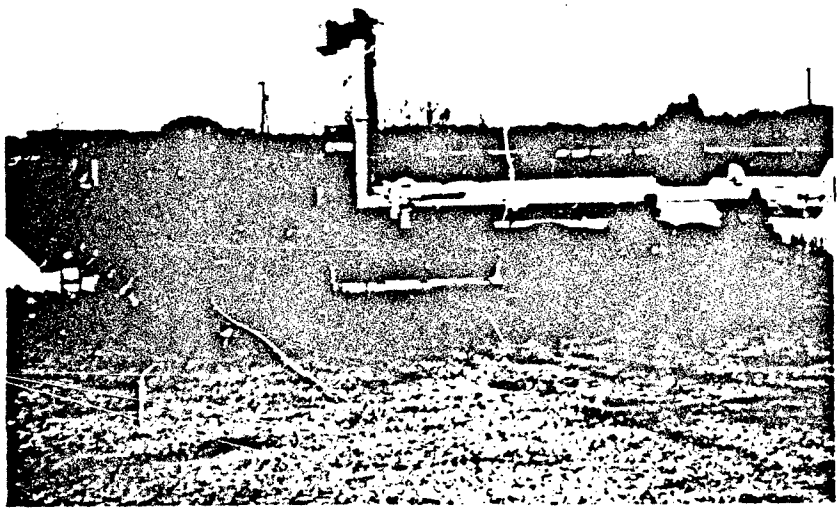


Photo 32. The BAP is locked down onto the Transporter

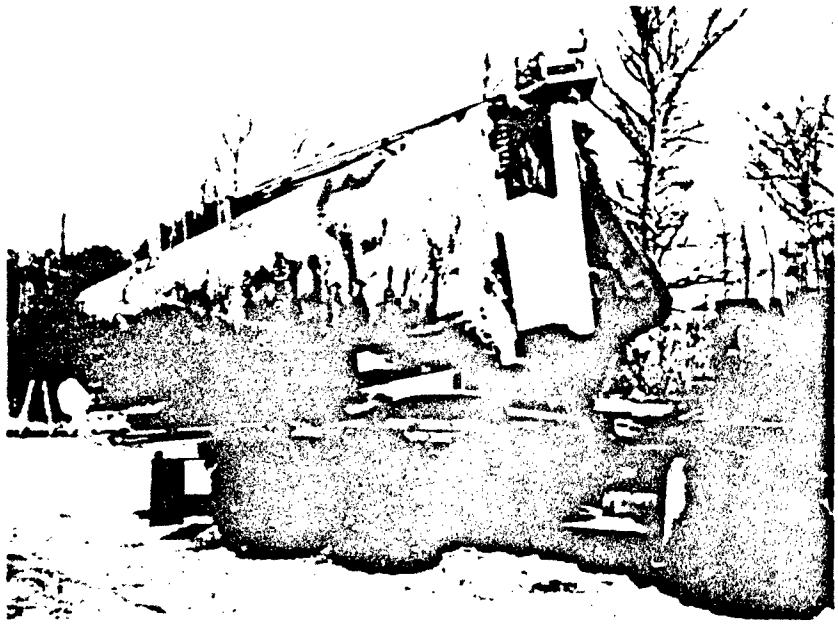


Photo 33. The hook arm lowers the BAP and bay onto the truck

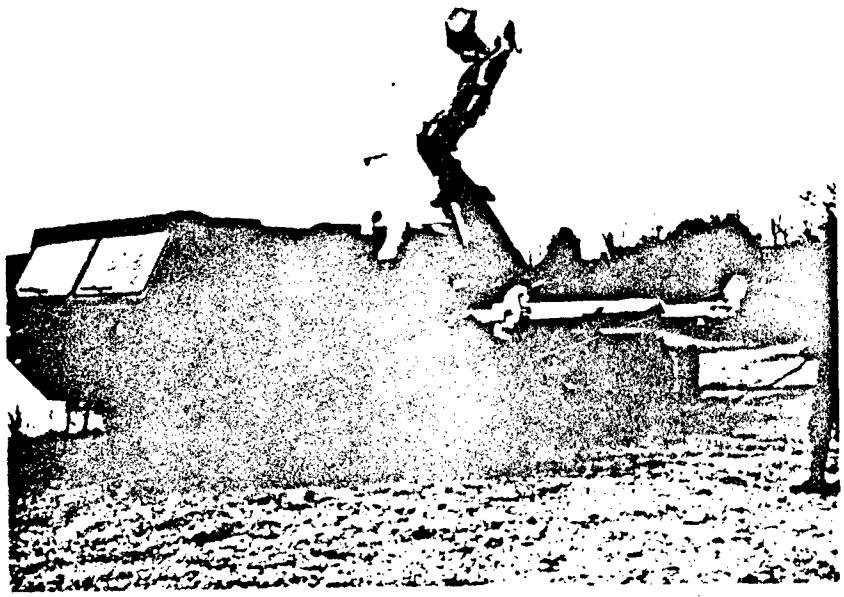


Photo 34. The winch frame becomes part of the hook arm

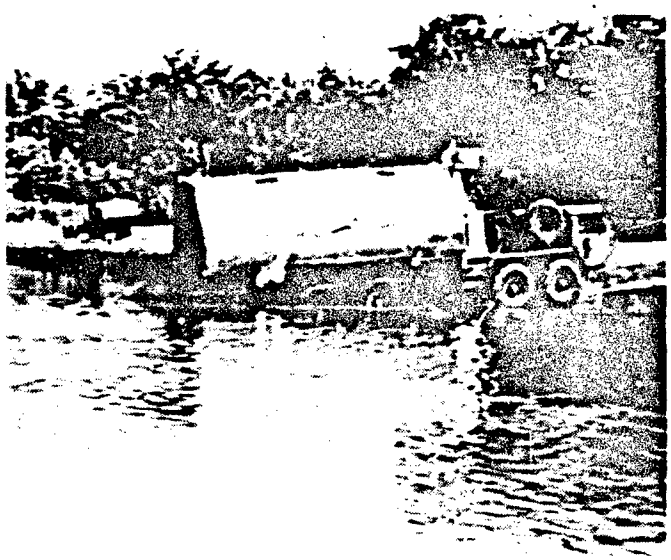


Photo 35. The interior bay hangs over the BAP by approximately 4 feet

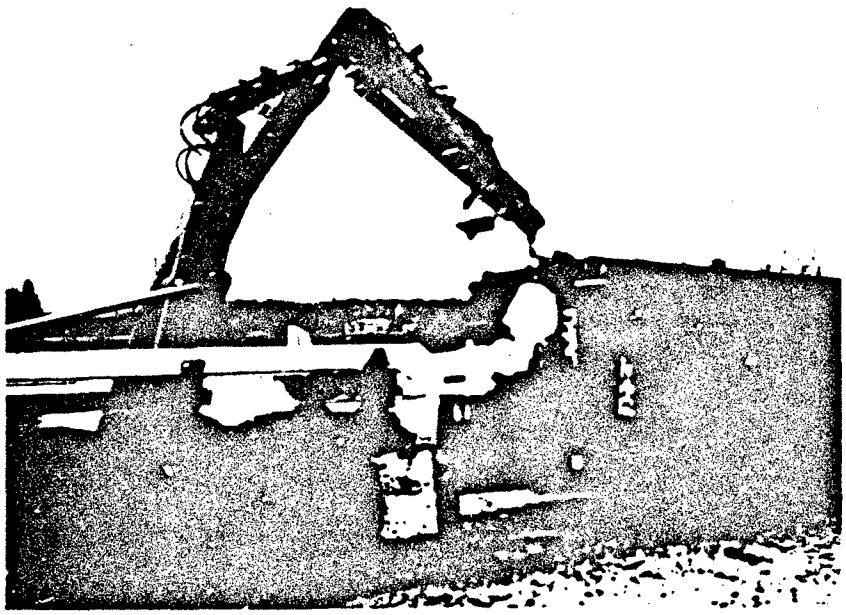


Photo 36. The winch lifts the bay off the ground and the middle frame is ready to retrieve the bay onto the truck

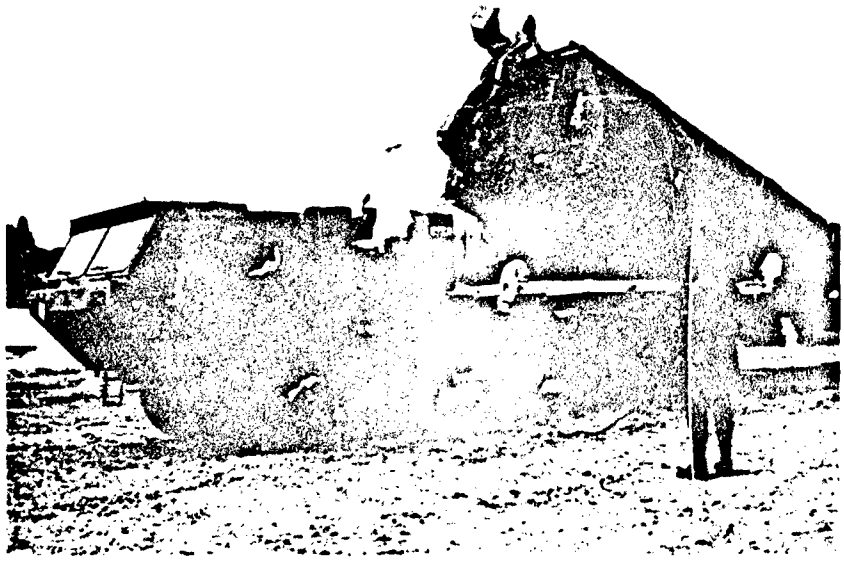


Photo 37. The interior bay rests on the rear rollers as it is loaded onto the Transporter

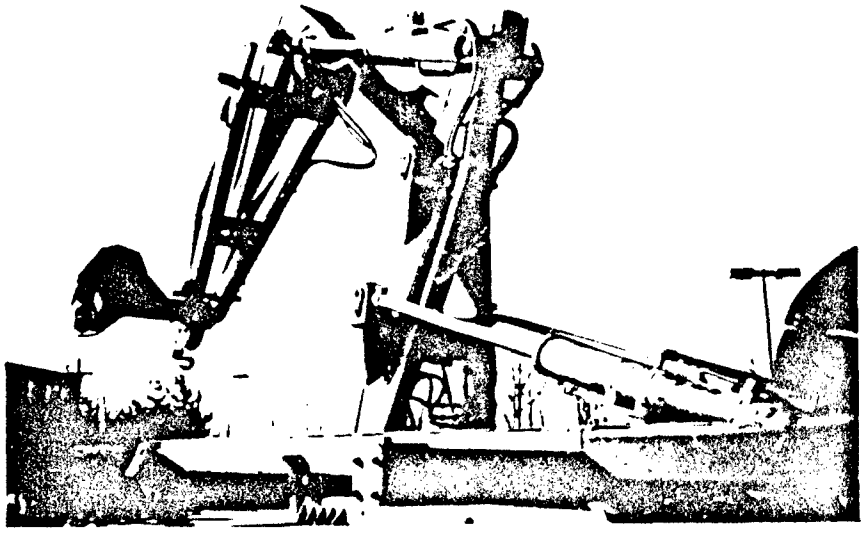


Photo 38. The hook arm should not be extended beyond 8 inches when retrieving a bay

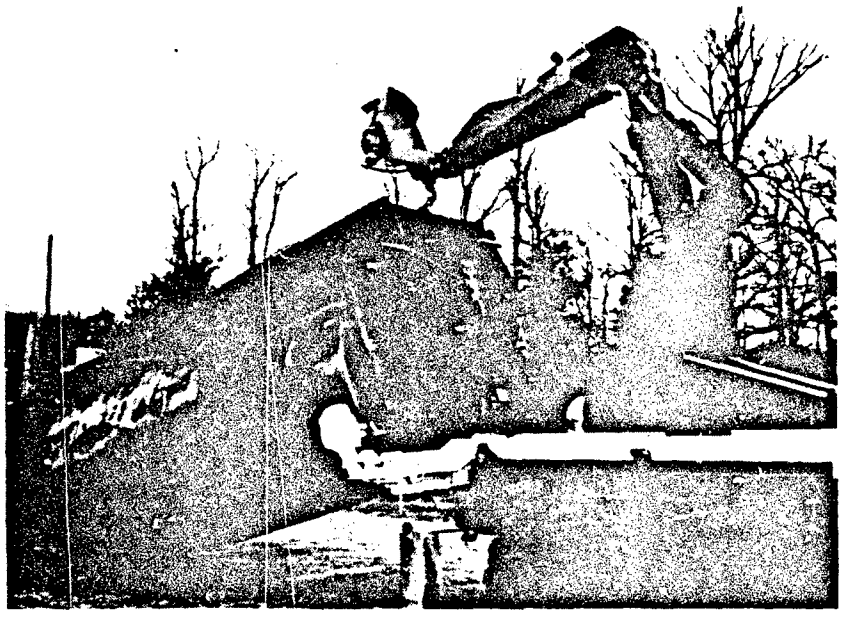


Photo 39. The bay is interfering with the rear rollers and bay guide because the hook arm is extended too far

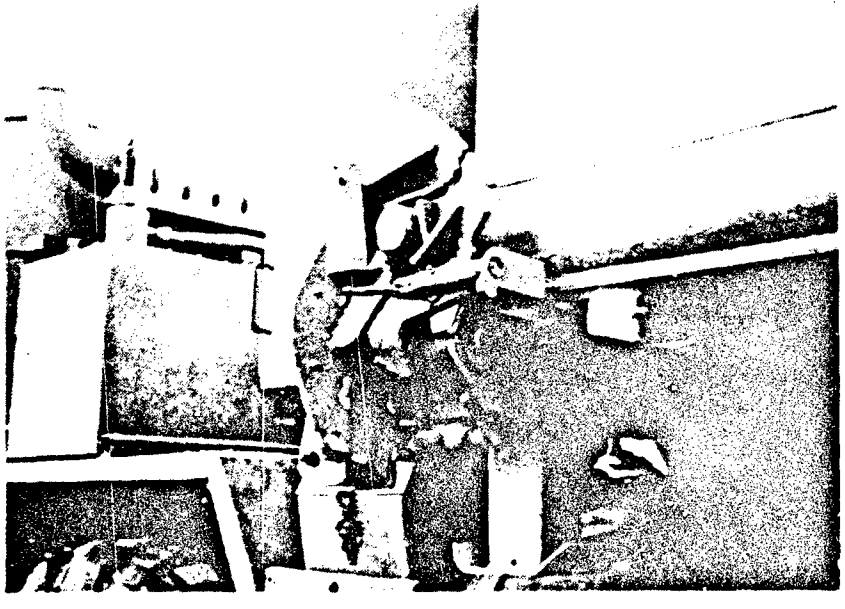


Photo 40. Interference between the lockdown assembly and the pin on the bay prevents release

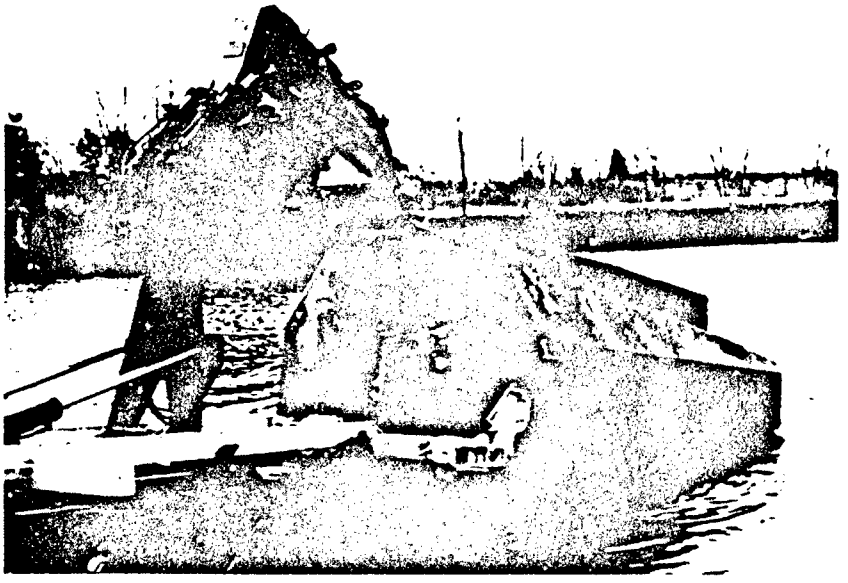


Photo 41. The bay is winched in and bumped against the rear of the BAP until it is parallel with the Transporter

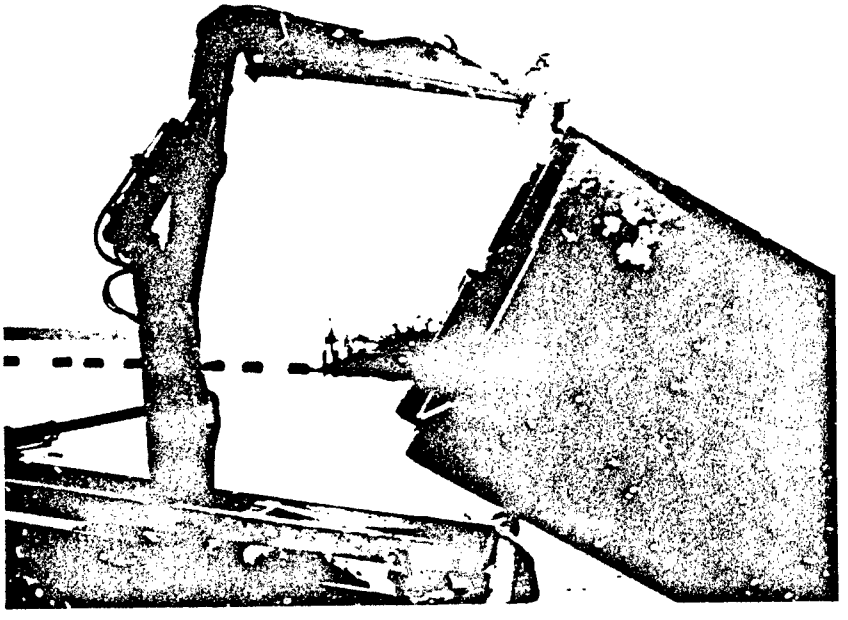


Photo 42. The bay is lifted over the rear rollers

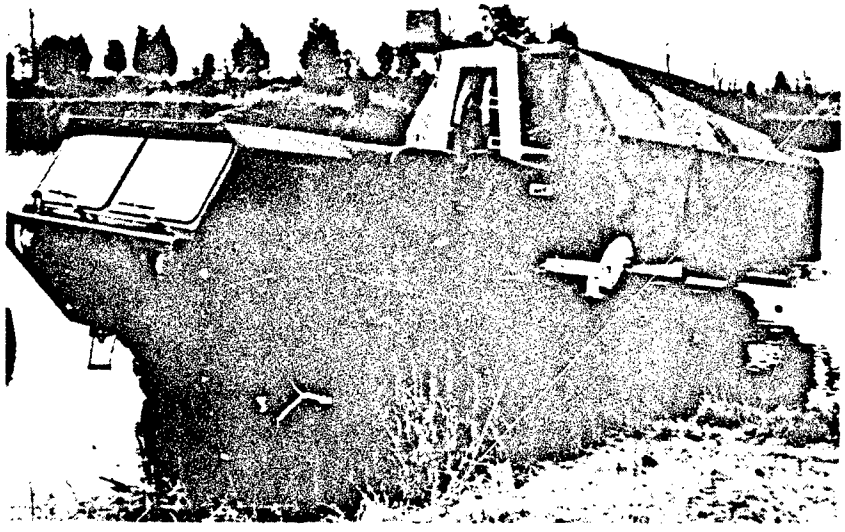


Photo 43. The bay is retrievd onto the truck and ready to drive away

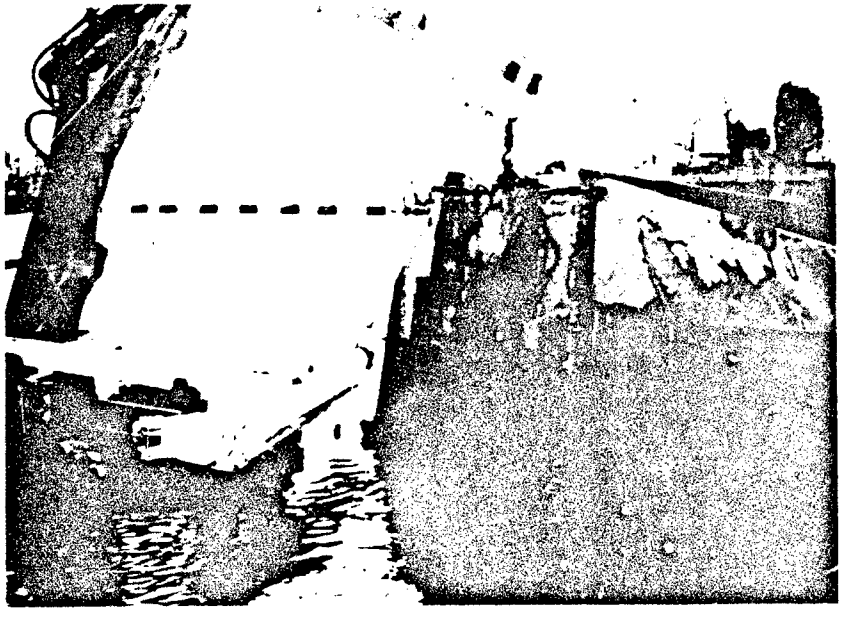


Photo 44. When the bay turns sideways, the lockdown pin can get caught on the rear of the BAP

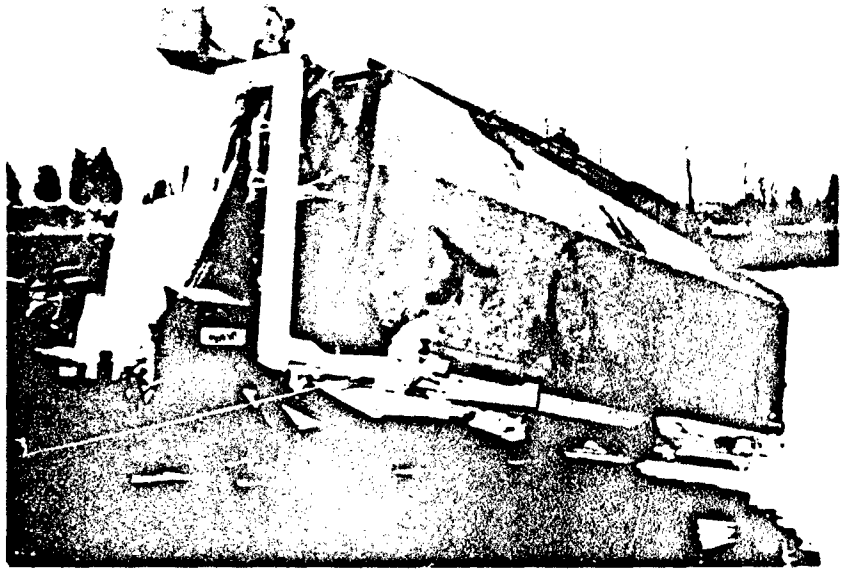


Photo 45. The BAP is tipped up for free launch

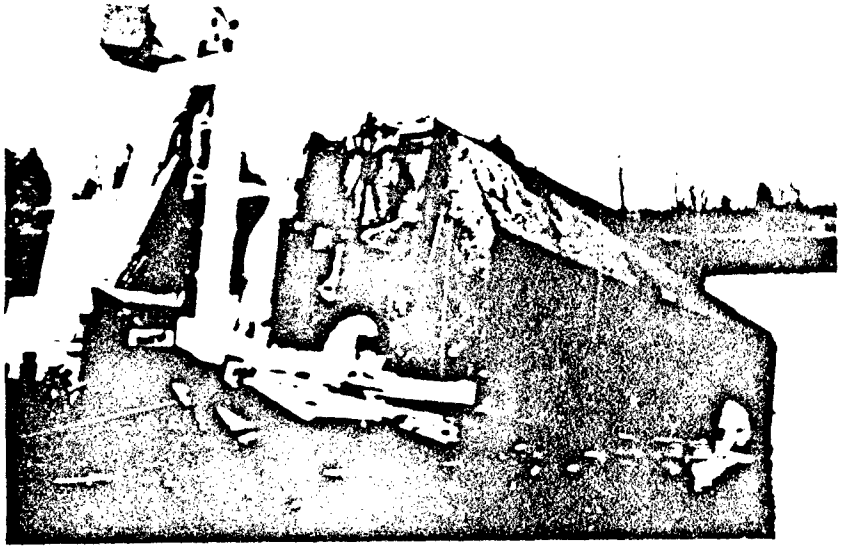


Photo 46. The bay is sliding off of the BAP

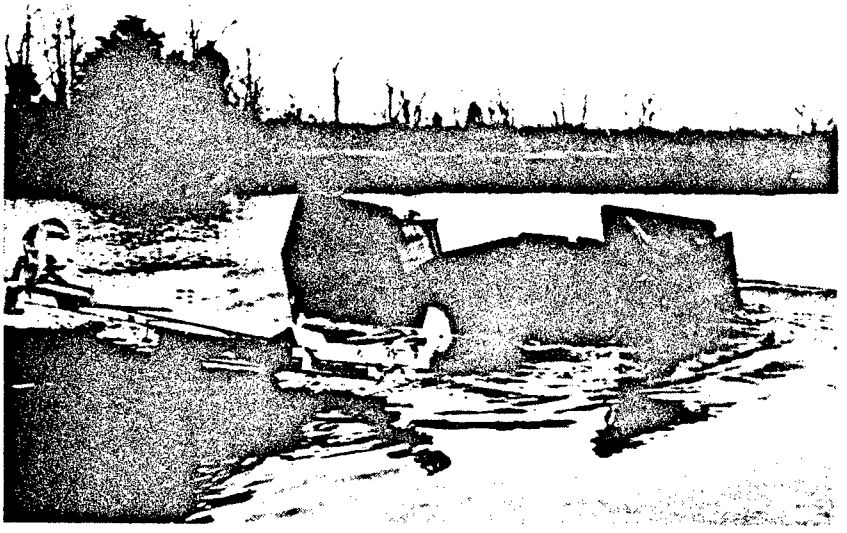


Photo 47. The bay clears the BAP and unfolds in the water

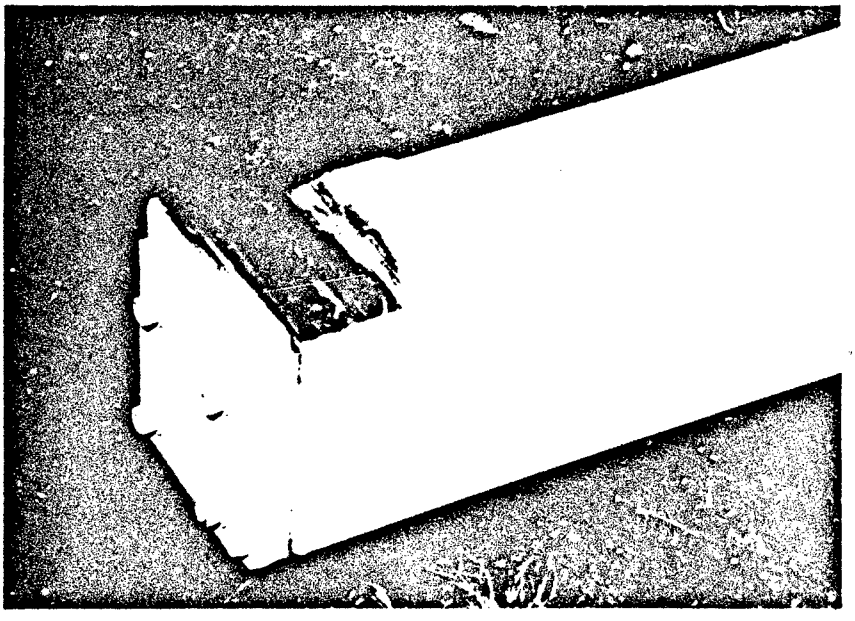


Photo 48. The front resting pads were worn by launch and retrieval

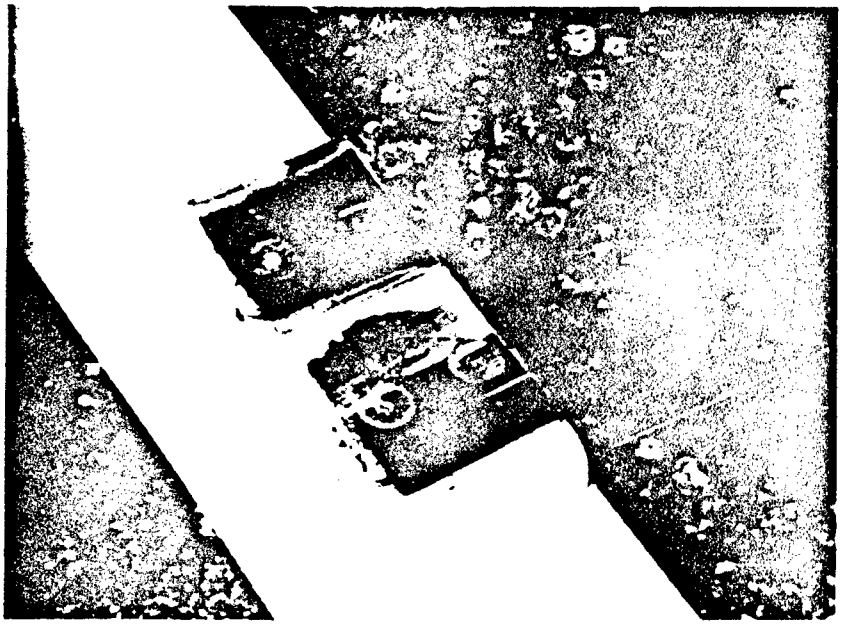


Photo 49. The center slide pad was worn by the ramp bay

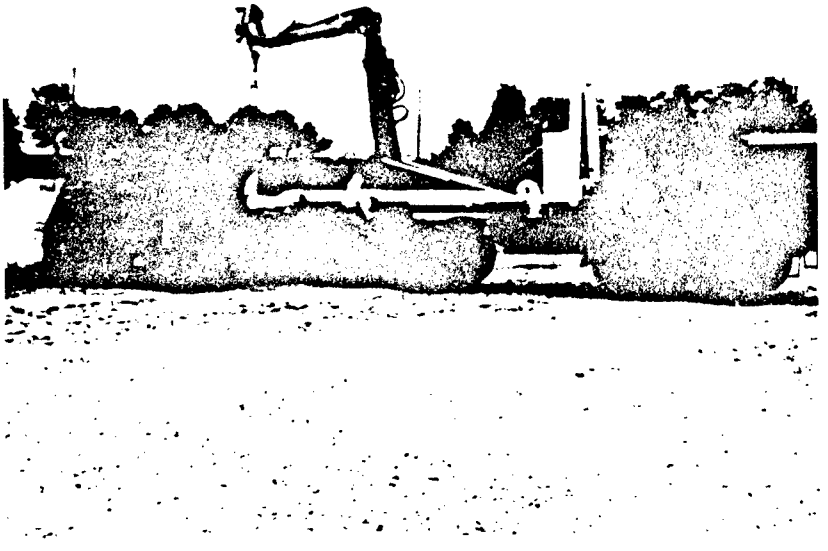


Photo 50. The interior bay is set up for a high bank launch

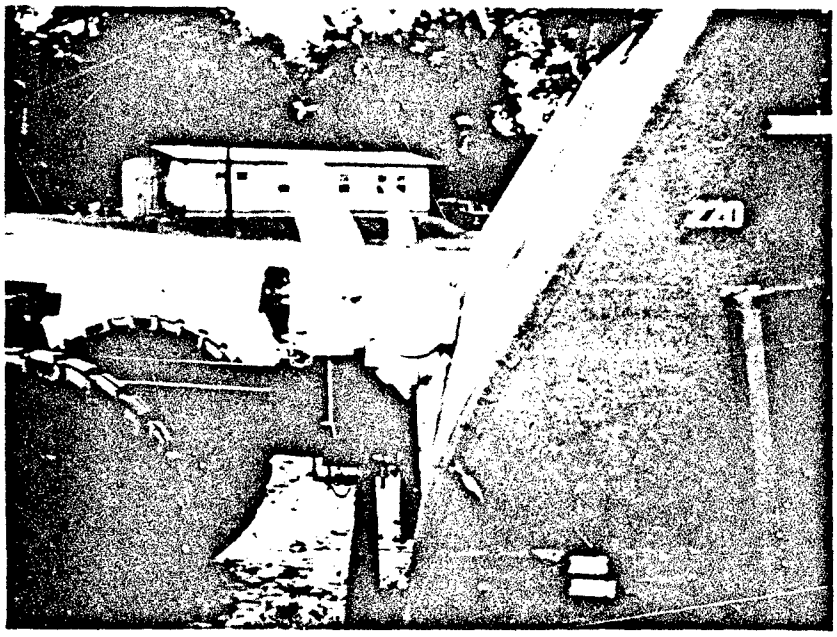


Photo 51. There is metal on metal contact when the bay rests against the BAP

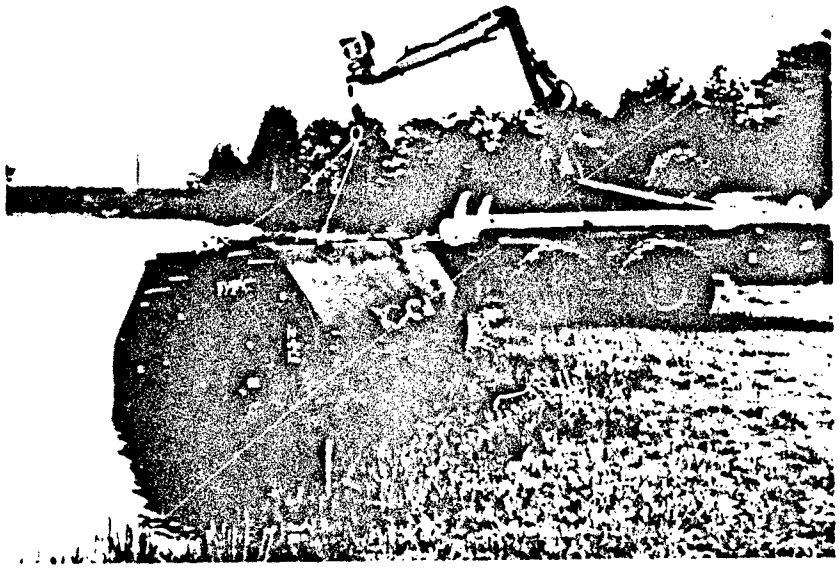


Photo 52. The bay is lowered into the water

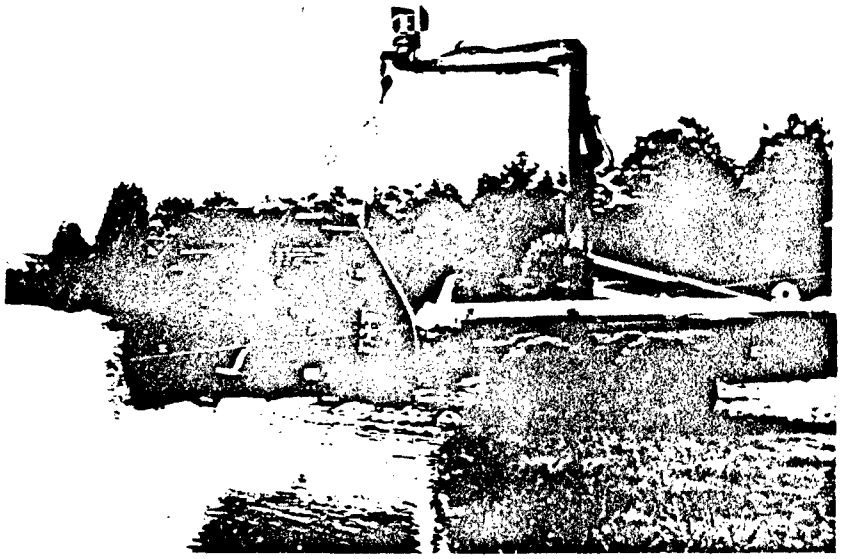


Photo 53. The interior bay slung with unequal sling cable lengths

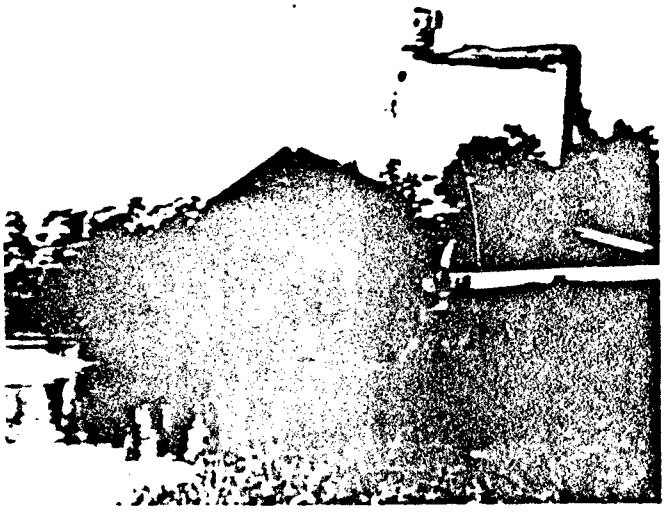


Photo 54. The high bank launch setup of the interior bay when equal lengthed sling legs were used

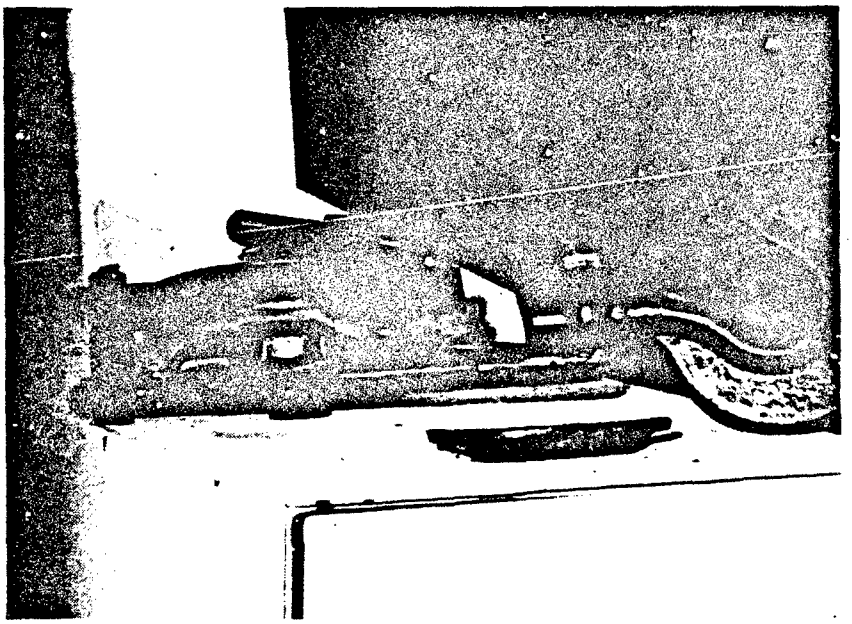


Photo 55. The snatch block was damaged when the cable was winched in too far

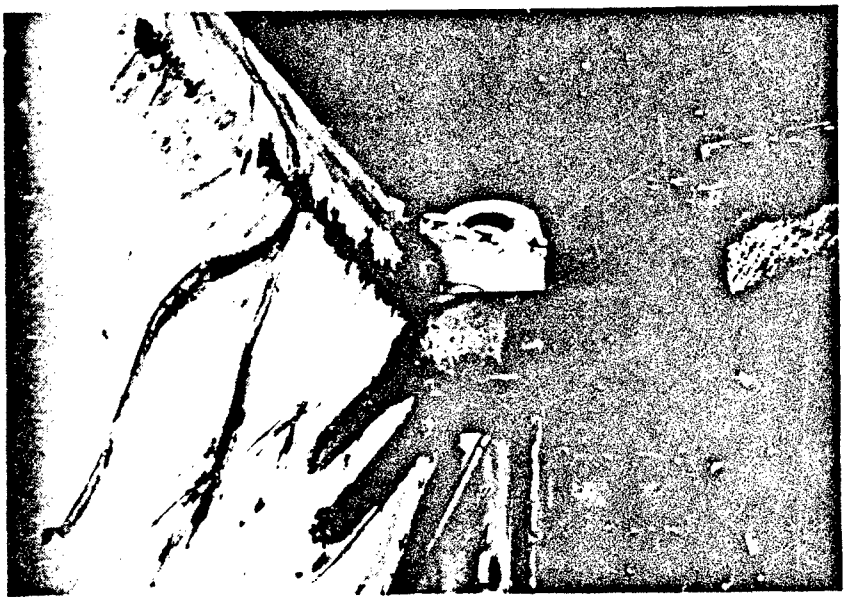


Photo 56. After extended use, the fit between the rear lockdown assembly and the pin can become loose

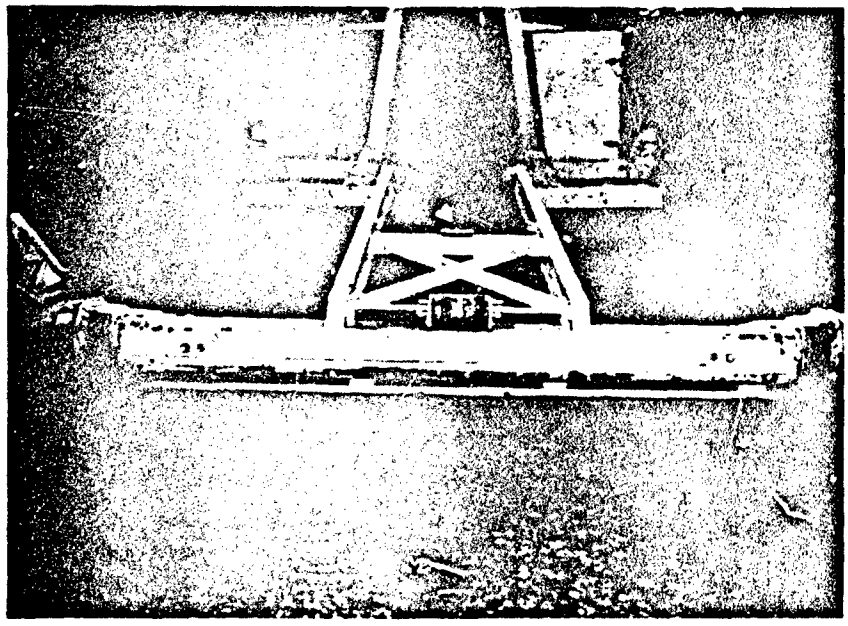


Photo 57. There is a gap between the rear bumper and the ground support on the rear of the BAP

Appendix B
Test Results

TEST RECORD FORM
HEMTT-PLS/BAP-RIBBON BRIDGE INTEROPERABILIT

TEST: A Initial Inspection of Hemtt

DATE: 25 Jan 90

NOTE(S): Oil level low - 3 quarts added
hydraulic oil low - 2½ quarts added
fuel gauge not working. Ground wire not attached
PLS arm operated from caband remote control at
different speeds
Completed 5 cycles without incident

INCIDENT(S):

DIAGRAM(S):

Launch and Retrieval of 16-ton Standard PLS Flatrack

TEST RECORD FORM
HEMTT-PLS/EAP-RIBBON BRIDGE INTEROPERABILIT

TEST: Results (A) Launch & Retrieval of 16 ton Standard PLS Flatrack

DATE: 29-30 Jan 90 Crew - Sgt. Williams, Kent Mitchell

NOTE(S): Test ① 2 person crew = pick up and set down - Remote control
② 2 person crew - pick up retrieve - operate from cab
③ 1 Man crew = complete cycle - unload PLS - backup - pickup & disp off - At idle speed ≤ 5.55" or 5:52 off ? 600 RPM
④ 1 Man crew - complete cycle at high idle ≤ 2'32" or 2'15" off ?
RPM @ 1000 - 1300.
⑤ 1 Man crew = Pick pallet up @ angle (3°) - Pick up & set down heavy side

INCIDENT(S): ① No incidents - Pallet slid on Mod / Rotated truck forward unhook
② No incidents - " " /
③ No incidents - " " /
④ PALLET INTERFERED WITH Remote control box and dented it.
⑤ No incidents
- Hydraulic oil leakage on right side of breather - Seems to be slow leak Dipstick

DIAGRAM(S):

Tests: 1, 2, 3, 4 = PARALLEL

TEST RECORD FORM

HEMTT-PLS/BAP-RIBBON BRIDGE INTEROPERABILIT

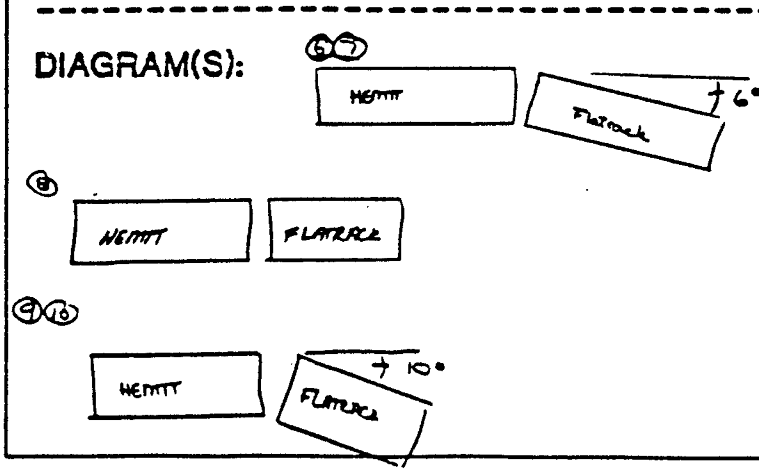
TEST: Run [6] Launch & Retrieval of 16 Ton Standard PLS Flatrack (pg 2)

DATE: 30 Jan 90

NOTE(S): (6) 1 Man crew pallet shifted ≈ 6° idle speed - Pick up & set down (cab)
(7) 1 Man Crew - 6° angle - high idle - loaded in 1'12" unloaded 1'15"
(8) 1 Man Crew - drop & reload - High idle 51 seconds to load
(9) 2 Man Crew - Remote box - drop & pickup - Complete cycle 5'10" (≈10°)
(10) 1 Man Crew - Cab - drop & pickup - Complete cycle 5'04" (≈10°)

INCIDENT(S): (6) No incident - Came in on roller and slid into place
(7) No problems - Came in on roller
(8) No incidents
(9) No incidents - Came in on Roller
(10) No incidents " " " "

DIAGRAM(S):



Launch and Retrieval of Empty and Preloaded Bridge Adapter Pallet (BAP)

TEST RECORD FORM
HEMTT-PLS/BAP-RIBBON BRIDGE INTEROPERABILIT

TEST: Launch / Retrieval of Unladen Bap (C)

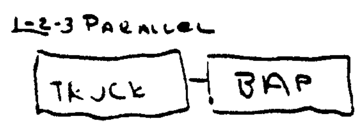
DATE: 29 Jan 90 - 30 Jan 90

NOTE(S): Test # 1 BAP on Truck - Latches thrown, hydraulics disconnected, launched & Retrieved.
(2) Pick up on truck and connect 7 minutes
Disconnect & set down Time - 5 min 29 sec
(3) Pick up & connect - 6 1/2 minute
Disconnect & set down - bring arm in [illegible] - 6 min 33 sec
Hard to operate hydraulic lines with gloves

INCIDENT(S): (1) PTO had to be re-engaged to get pressure off hydraulics so that they could be connected
(2) Lines did not relieve 1st time. Had to [illegible] and do again. Left swing arm lights on [illegible]
(3) Hydraulics - 2 large [illegible] - [illegible] to function

QD's leaking out of fluid

DIAGRAM(S):



TEST RECORD FORM

HEMTT-PLS/BAP-RIBBON BRIDGE INTEROPERABILIT

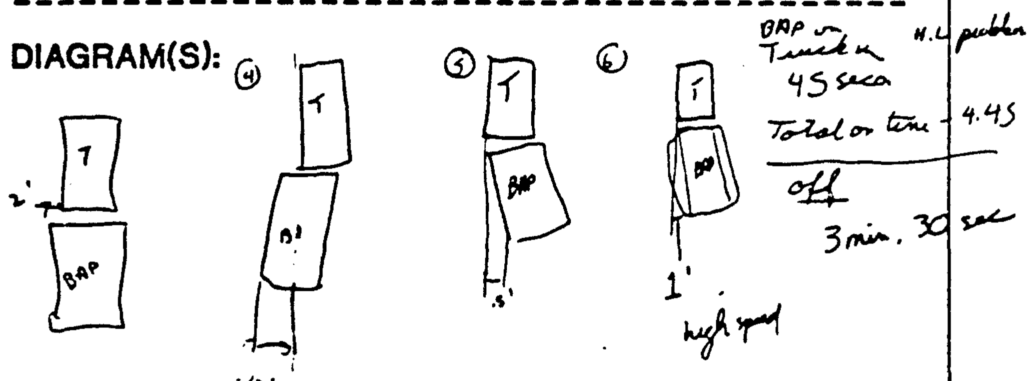
TEST: BAP - Empty - Pick up / Unload - (c)

DATE: 30 Jan 90

NOTE(S): (c) Rt. side thrown first, then left side
Hydraulic lines hard to get out of storing plate.
Unload - latches all work well. Time - 6.5
(5) Put on truck 6.47
Put down 3.25

INCIDENT(S): (4) No problem with safe. Problem with hose stall
(5) In order to install lines had to slip PTO throws
Unload - no problems - speed up RPM

DIAGRAM(S):



TEST RECORD FORM
HEMTT-PLS/BAP-RIBBON BRIDGE INTEROPERABILIT

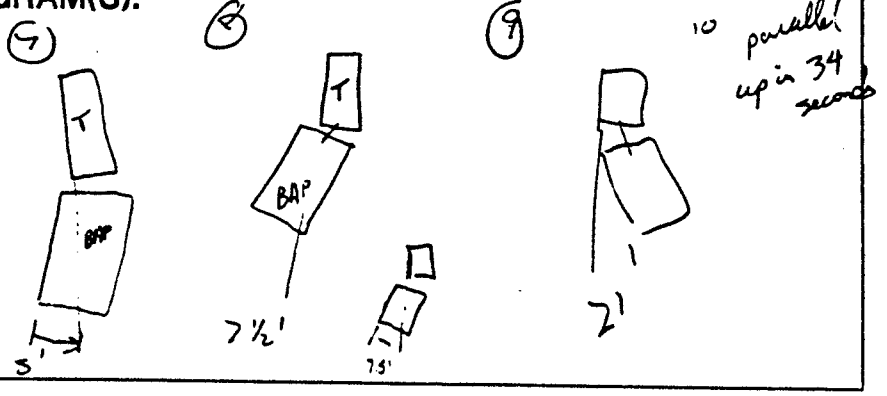
TEST: Pkt up & drop of BAP - empty

DATE: 30 Jan 96

NOTE(S): (7) 40-45 seconds coming up. No problem with angle. Bt swing area stuck. Have to maneuver to free. Unload - normal idle speed - everything disconnected - 5.20
(8) Loading Jack 5'2" above ide
Unload - 5.00
(9) Load - no reference
Ha 3 min 10 sec 40 sec cycle

INCIDENT(S): (8) hit edge of rear rollers coming up. Miss anch for picking up.
(9) - Rob with 2 Hydraulic lines

DIAGRAM(S):



TEST RECORD FORM
HEMTT-PLS/BAP-RIBBON BRIDGE INTEROPERABILIT

TEST: Load & Unload BAP loaded with Ramp Bay

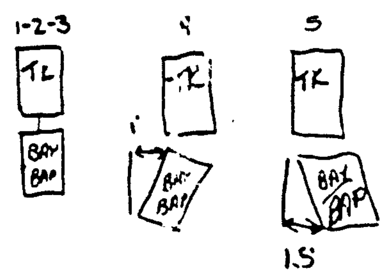
DATE: 31 Jan 92

NOTE(S): 1) Unload BAP & Bay – Need to payout winch, throw levers, retighten winch and disconnect AD's – 6:30 seconds
Load – hook hydraulics before throwing levers. Throw levers & load. Time [illegible]
2) Same operation, difficult to throw latch, 13 minutes @ idle
3) High idle – No problems – 8:40 [illegible]
4) Angle load – No difficulty
5) Angle load – No difficulty

INCIDENT(S): Connection problems with hydraulics. Replaced plastic cap on hydraulic line storage port

System works better when bay is tight on BAP.

DIAGRAM(S):



TEST RECORD FORM
HEMTT-PLS/BAP-RIBBON BRIDGE INTEROPERABILIT

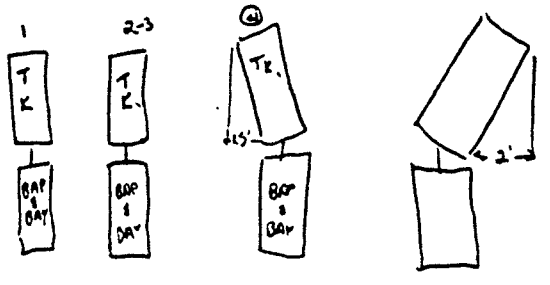
TEST: ⑥ Launch and Retrieval of RIBBon Bridge Adapter Pallet (BAP)

DATE: 6 Feb 90

NOTE(S): ① Unload cycle: 3 min. stabilizer unhook 2:40 unload operation
load cycle: 2:30 load 4:30 hookup (@ idle)
② 3:29 unhook & unload; 8:05 pick up and hook (high idle)
③ launch & Retrieval unload difficulty
④ Complete cycle - 9:15 (high idle) - Angle
⑤ Complete cycle - 9:30 (high idle) - Angle

INCIDENT(S): No major problems. Hard to engage hydraulic lines after pickup.
5th test: Boy was not watched tight against BAP frame
Frame flexes but no noticeable problem

DIAGRAM(S):



Launch and Retrieval of Ribbon Bridge Bays to Ground

TEST RECORD FORM
HEMTT-PLS/BAP-RIEBON BRIDGE INTEROPERABILIT

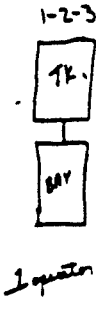
TEST: ① Launch & Retrieval of Bay from ground to Truck

DATE: 30 Jan 92

NOTE(S): ① Hooked from transport - Unloaded - Slight interference on rear rollers of truck - Had to bring Unload forward to raise front of Bay to clear rear rollers
② Loaded - 2105 @ idle - No problems (Locked down fine)
Unloaded 3100 @ idle - No problems
③ Hi-idle - 1106 - Up / 1102 Unload

INCIDENT(S): ① Was slipping off rollers Had to back off and drive under BAY
② Not setting on rear rollers

DIAGRAM(S):



1 quarter

TEST RECORD FORM
HEMTT-PLS/EAP-RIBBON BRIDGE INTEROPERABILIT

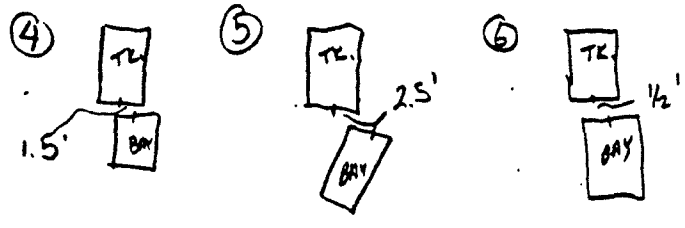
TEST: ④ Launch and Retrieval of Rear Bay from Ground to Truck

DATE: 30 Jan 92

NOTE(S): ④ Pick up ramp, pedal, 1½ ft offset. Not using on rear roller. Unload (3:33)
⑤ 2½' offset - Didn't load
⑥ Cleared rear roller locked down at

INCIDENT(S): ④ Bridge bump up on right rear = cable wasn't pulled in. Front bolting pin got caught on rear guard. Visual inspection. Everything ok.
⑤ Fortescue with rear end. Worked Pick up Pedal just fine

DIAGRAM(S):



TEST RECORD FORM

HEMTT-PLS/BAP-RIBBON BRIDGE INTEROPERABILIT

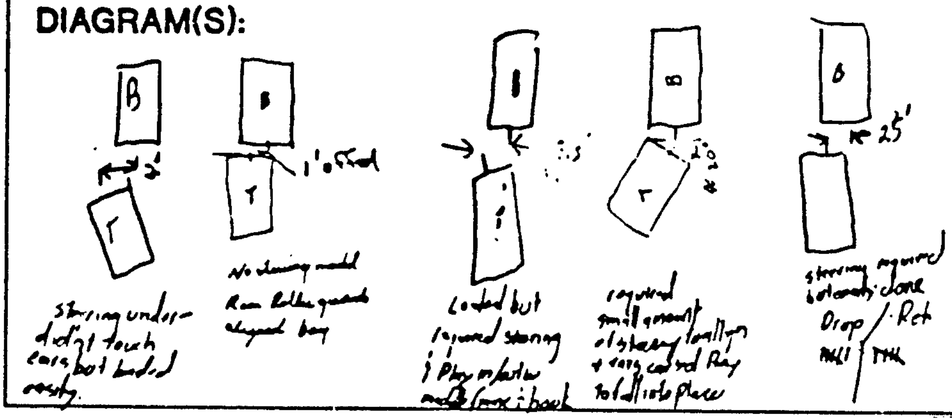
TEST: Interior Bay To ground

DATE: 1/9/90

NOTE(S): Loading was accomplished quickly ĉ 2 minutes per load ĉ Bay unloaded at ĉ 500 RPM. Steering under bridge is required for significant misalignment. Bay & Truck Ears functioned properly ĉ small amount of fouling of the rear ears by the stand up pins was observed but insignificant. Rear roller ears did help with the alignment of the bridge to the truck as did the ability of the winch to drag allowing the bay to self [illegible]. Note after tests when [illegible] locks were [illegible] hook [illegible] together [illegible] & [illegible] pinning were required to keep track without locks.

INCIDENT(S): None

DIAGRAM(S):



TEST RECORD FORM
HEMTT-PLS/BAP-RIBBON BRIDGE INTEROPERABILIT

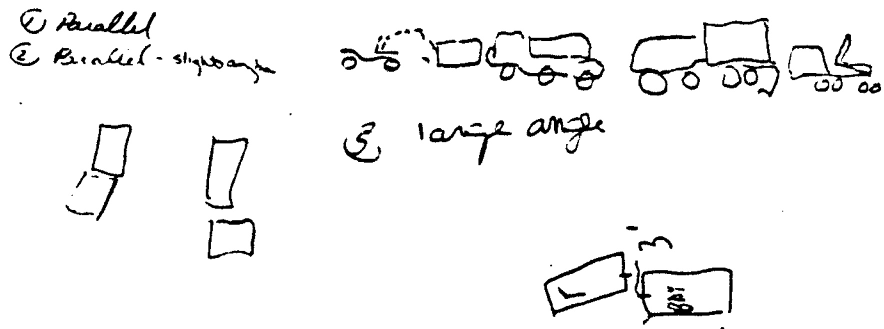
TEST: Load / Unload Interior Bay from BAP

DATE: 2 Feb 1996

NOTE(S): ① Unload/load - Left front locking pin needed to be pushed off - 4:35 - [illegible] - Load time - 2:55 once [illegible] turned
② Total cycle - no stops - 12:20 No incidents
③ " " no stops 9:50 No incidents 1 person unload - pull away and re load
④ Total cycle @ hi idle 7:52 no incidents - drive under
⑤ " " slow - 11:58 - [illegible] already out -

INCIDENT(S): ⑤ - Had to [illegible] [illegible] slightly and manipulate to clear rollers. Drive under.
All tests done by one operator
CANT PUT [illegible] [illegible]

DIAGRAM(S):



Controlled Launch of Ribbon Bridge Bays in Water

TEST RECORD FORM
HEMTT-PLS/BAP-RIBBON BRIDGE INTEROPERABILIT

TEST: (E) Controlled Launch of I.B.

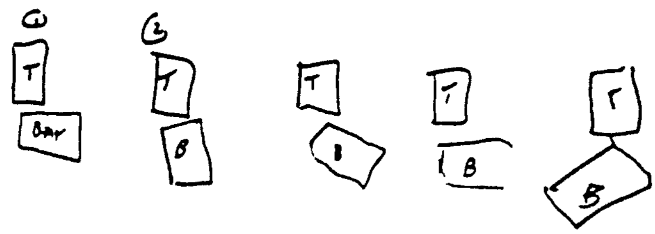
DATE: 7 Feb 90

NOTE(S):
(1) No problems - slipping Truck - catwalk pos?
(2) No problems - have to move around (up [illegible])
(3) hi speed - No problems
(4) hi speed - 6:41 Total 2:48 unlatched & dropped - 50 seconds coming in
(5) hi speed - 6:58

INCIDENT(S): Bring Bay in slowly @ first will bump around into position

Have to climb out onto Truck to adjust bay lockdown points. Catwalk would be helpful.

DIAGRAM(S):



TEST RECORD FORM

HEMTT-PLS/BAP-RIBBON BRIDGE INTEROPERABILIT

TEST: Control launch - RB (E)

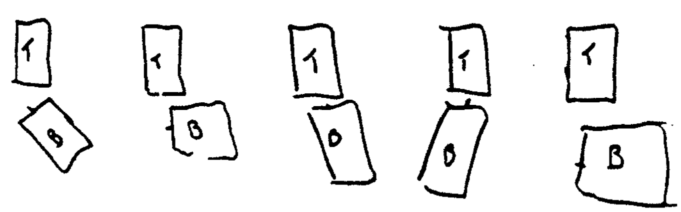
DATE: 7 Feb

NOTE(S): (1) 15 min - 30 sec - Need deep water to launch
(2) Roller left down and out - Still come in. They moved with a finder distance to keep on rollers
(3) 8 min total - begin water 38 sec - 2 ... Camera 1:18 sec
(4) Roller guide left down and out
(5) 7:15 total - begin water 1:04 seconds 1:06 sec

INCIDENT(S): No major problems - scraping on rear of BAP - to ... the bridge section

Bay dives into water deeper. Need to boom hook arm out further

DIAGRAM(S):



Free-Launch of Ribbon Bridge Bays from HEMTT

TEST RECORD FORM
HEMTT-PLS/SAP-RIBBON BRIDGE INTEROPERABILIT

TEST: Free launch - interior bay - (F)

DATE: 8 Feb 1990 / 12 Feb 1990

NOTE(S): ① 5 min launch - 9:48 returned - 14 min 48 sec
② 3:56 launch - 9:42 returned - 13 min 46 sec
③ 3:45 launch - 9:33 returned - 13 min 48 sec
④ 4:05 launch - 10:12 returned - 14 min 17 sec
⑤ 3:22 launch - 12:02 returned - 15 min 27 sec

INCIDENT(S): Lanyard a little difficult to pull
behind working vessel - Bay sliding off better

DIAGRAM(S):

TEST RECORD FORM
HEMTT-PLS/BAP-RIBBON BRIDGE INTEROPERABILIT

TEST: (F) Free Launch Ramp Bay

DATE: 13 Mar 90

NOTE(S): (1) Hookarm cylinder extended 8 inches. Not sitting on rear roller. Worked ok.
(2) 5:45 Unload, 13:28 load. Need truck to be in water deep enough.
(3) 3:33 Unload and setup 12:58 load.
(4) Difficult to pull lanyard. Lever arm seems to hit rear support (13:43 Total)
(5) No problem

INCIDENT(S): If Bay is pushed by current Totally sideways, pin tends to want to catch under ground plate of Bay. Bay will bump on rear of BAP until it is parallel.

Cable on winch was reeved out and straightened out

DIAGRAM(S):

TEST RECORD FORM
HEMTT-PLS/BAP-RIEBON BRIDGE INTEROPERABILIT

TEST:_For launch of Bay (F)_____

DATE:_____

NOTE(S):_After testing there have been numerous deactivation and operation of Truck. Cable failed during one test. Results of poor repair work. Operator of boat, bay could be picked up in fast water. Winch still has operation problem. Not enough cable and tension does not work well.
_____
_____

INCIDENT(S):_____
_____
_____
_____
_____
_____
_____

DIAGRAM(S):

High Bank Launch of Ribbon Bridge Bays

TEST RECORD FORM
HEMTT-PLS/BAP-RIEBON BRIDGE INTEROPERABILIT

TEST: High Bank launch = Ground ⑥

DATE: April 11 - RAMP. May 4 - INTERIOR

NOTE(S): 5 cycles of each = Picked up and set down. No major problems. Bay scrapes on rear of BAP. IB picked up with uneven sling length. Picked up level.

INCIDENT(S): Quick disconnect not fully engaged causing leakage of fluid. Cable wrenched in tow fork cracking piece off of high bank sling pulley.

DIAGRAM(S):

INTERIOR BAY

Bay butted up to rear of truck

DEFLECTION

DEFLECTION MEASUREMENTS		
LOCATION	Before	After
Rear Wheel	16"	15"
Frame Rail - Rear	37 7/8"	34 3/4"
Leaf Spring	5 3/8"	5"
Frame Rail @ Leaf Spring	41 3/4"	41 3/8"

TEST RECORD FORM
HEMTT-PLS/BAP-RIEBON BRIDGE INTEROPERABILIT

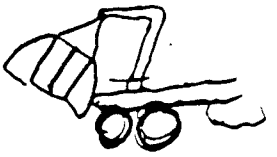
TEST: High Bank launch / Water-Ribbon ⑥

DATE: July 27, 92

NOTE(S): Picked speed set down. Equal length trial
on picking up interm Bay
Works ok but scrapes bay

INCIDENT(S):

DIAGRAM(S):



Appendix C

Multilift Bridge Adaptor Pallet Operator's Guide

SAFETY

Death or severe injury to personnel and damage to equipment may result if personnel fail to observe safety precautions whilst operating this equipment.

- **Use extreme caution when connecting Bridge Bays.**
- **Make sure you have a secure footing when working with Bridge Launching Equipment. Slipping etc may result in severe injury.**
- **When disconnecting hydraulic lines, open line slowly and ensure face is protected. Hydraulic oil may spray out due to residual pressure in the system.**
- **Always wear leather gloves when handling winch cable and never allow cable to run through hands.**
- **Always ensure transport locks are properly in place before driving vehicle on roads.**
- **Always ensure that relevant safety equipment ie flags, wide load signs are positioned before driving vehicle on roads.**
- **In common with all demountable body systems the equipment should only be operated by an authorised operator.**
- **Ensure that operating area is clear of personnel before demounting body.**
- **Ensure that no personnel are on the rear of the vehicle when operating either BAP or Load Handling System (except for an operator mounted in the operator's platform position).**
- **Ensure that "No transit" light on LHS controls is extinguished before moving vehicle.**

INDEX

The following instructions are an operator's guide only and should be utilised in conjunction with experience and common sense. They should be used in conjunction with the vehicle operator's guide and the Operator's Manuals for the relevant Folding Float Bridge Bays.

Any errors, observations or omissions should be reported to Multilift Ltd, Government Business Operations, Harlescott Lane, Shrewsbury, Shropshire, England, SY1 3AG

CHAPTER 1

Loading of the Bridge Adaptor Pallet from the ground with or without Bridge Bay.

1. **Ensure vehicle is in safe operating area and condition.**

1.1 **Mount vehicle, start engine and manoeuvre vehicle towards the Bridge Adaptor Pallet.**

1.2 **Engage power take-off.**

1.3 **Adjust vehicle idle to set engine speed at approximately 1500 revs per minute.**

1.4 **Using Load Handling System controls load the bridge adaptor pallet as per a normal flatrack, ie extend hookarm and middle frame cylinders using automatic mode or manual mode in the unload direction until the hook on the load handling system is adjacent to the hook bar of the bridge adaptor pallet. Manoeuvre the vehicle until the hook is engaged with a hook bar. Using the load handling system controls in the load direction (automatic or manual mode) load the bridge adaptor pallet taking care that the main runners of the bridge adaptor pallet engage the rear rollers of the load handling system, (the vehicle may need to be steered under the bridge adaptor pallet). When bridge adaptor pallet is clear of the ground apply vehicle handbrake. Ensure that bridge adaptor pallet is fully loaded, this is indicated by the "No-transit" light on a load handling system controls going out.**

1.5 **Working from the ground lock bridge adaptor pallet frame locks by turning the spring loaded pin handles in a downwards direction (one lock on each side of load handling system towards the front of each side).**

1.6 **Mount operator's platform and unlock the control lockers.**

1.7 Disconnect the 3 winch hoses of the bridge adaptor pallet from their stowage locations and connect to the quick disconnects mounted on the bottom of the hookarm. Connect the smaller (drain line) first. The two large lines are male and female so cross-connection is not possible. Disconnects should be pushed home quickly and firmly as a little residual pressure remains in the pipes.

1.8 Using the remote control location on the operator's platform in manual mode drive the hookarm and middle frame down and using the two locking levers mounted on the bridge adaptor pallet winch frame, secure the winch frame to the hookarm of the LHS. The locking levers are turned in an upwards direction and secured with their safety pins. Note: there is a 45 second delay in the LHS hydraulic system before the transit circuit operates making connection impossible. If connection is found to be difficult, drive the hookarm and the middle frame down and try again.

1.9 If a bridge bay was already on the bridge adaptor pallet winch in and tighten the cable then release the cable tension by winching out to 5cm (2").

1.10 Working from the ground ensure the front locking ears are up and secured.

1.11 Working from the ground check the rear guide locking ears are in position and secured.

1.12 Disengage PTO.

1.13 Fit wide load sign and other warning devices to the rear of the vehicle.

1.14 Vehicle is now ready to move.

CHAPTER 2

Loading of the Bridge Bay from the ground.

2.1 Load bridge adaptor pallet as in Chapter 1. Drive vehicle to bridge bay, line up with rear of vehicle adjacent to front end of a bridge bay. Vehicle approximately in line with bay with approximately 1.5m (4'6") gap between bay and rear of vehicle.

2.2 Engage the vehicle handbrake.

2.3 Engage power take-off.

2.4 Adjust engine idle speed to approximately 1500 revs per minute.

2.5 If required operate vehicle bogie blocking system or suspension lock-outs.

2.6 Working from ground check bridge adaptor pallet frame locks are locked.

2.7 Check the front BAP locking ears are turned up noting the spring loaded pins should be in the correct position.

2.8 Check the release hook at the front left locking ear is locked (in its up position).

2.9 Check the rear guide locking ears are turned back and secured.

2.10 Mount the operator's platform and open control locker.

2.11 Check that the winch frame is locked to the LHS hookarm. The two locking levers should be in their up position and secured with safety pins, check that the 3 hoses are connected.

2.12 Using the operator's platform remote control, drive hookarm cylinders out approximately 20cm (8").

2.13 Drive out the main cylinders which will move the middle frame rearward until it is possible to reach the cable hook from the ground. Demount from the operator's platform with the remote control unit or by using another operator winch out approximately 1 (3') metre of cable.

2.14 Attach the cable to the lifting eye of the bay. The throat of the hook upwards. Check that the safety clip has operated. Check security of the bay transport locks.

2.15 Using the winch apply tension to the cable.

2.16 From the operator's platform winch in cable until flange of the hook lies lightly between the flanges of the cable guide.

2.17 Release vehicle handbrake directly or using remote control.

2.18 Bring middle frame of load handling system forwards and allow truck to roll under bridge bay checking that the lower edge of the bridge bay and tie-down lugs will pass freely over the rear rollers of the bridge adaptor pallet. The height of the bay relative to the rear rollers can be controlled by extending or contracting hookarm cylinders.

2.19 Continue to bring the middle frame forward. Intermittently move the arm rearwards to keep the bridge bay between the rear guide ears.

2.20 Engage vehicle handbrake when bay middle touches the rear rollers.

2.21 Continue to move middle frame until it is fully down then bring hookarm fully forwards.

2.22 Check to ensure bay is fully forwards.

2.23 **Release cable tension by unwinding approximately 2-5cms (1-2") cable.**

2.24 **Check that all four locking ears are completely locked.**

2.25 **Disengage bogie blocking or suspension lock-out if appropriate.**

2.26 **Reduce engine idle speed to normal.**

2.27 **Disengage PTO.**

2.28 **Position safety/wide load warning indicators. Vehicle is now ready to drive.**

CHAPTER 3

Unloading the bridge bay to the ground.

3.1 Manoeuvre the vehicle to the unloading position noting that the final unloaded bay position will be approximately 2.5m (8') more rearward than the rear of the truck.

3.2 Engage vehicle handbrake.

3.3 Engage vehicle PTO.

3.4 Adjust engine idle speed to set engine speed approximately 1500 revs per minute.

3.5 Operate bogie blocking or suspension lock-out if appropriate.

3.6 Working from the ground, turn down the two front locking ears by releasing spring loaded pins.

3.7 Turn the two guide/locking ears at the rear of the BAP to the side be removing the locating pins. Lock the ears in this position using the pin through the front-most location holes.

3.8 Ensure BAP frame locks are both locked.

3.9 Mount operator's platform and open locker.

3.10 Check the winch frame is securely locked to the LHS hookarm. The 2 locking levers being in their up position and secured with safety pins and that the 3 hoses are connected.

3.11 Check that the cable hook is attached securely to the lifting eye of the bay.

3.12 Winch in cable until hook flange lies lightly between flanges of the cable guide.

3.13 Extend hookarm cylinders by approximately 20cms (8").

3.14 Taking care that the winch hoses do not get trapped drive the middle frame rearwards to the point where the rear corners of the bridge bay touch the ground. Disengage the vehicle handbrake and allow the vehicle to roll forwards.

3.15 When the front of the bay is approximately 1m (3') above the ground, engage the vehicle handbrake and winch out cable until bay is completely on the ground.

3.16 Lower middle frame by approximately 0.5m (18").

3.17 Working from the ground remove the cable hook.

3.18 Operate the load handling system to bring middle frame and hookarm into normal transport position.

3.19 Turn up and secure front locking ears.

3.20 Turn and secure rear guide/locking ears to their rear position.

3.21 If applicable disengage bogie blocking or suspension lock-outs.

3.22 Reduce engine idle speed to normal.

3.23 Disengage PTO.

3.24 The vehicle is now ready to drive.

CHAPTER 4

Free Launch.

4.1 Assuming bridge adaptor pallet and bridge bay are loaded on to vehicle, drive the vehicle to launch site.

4.2 Engage vehicle handbrake.

4.3 Prepare the bridge bay for operation as per bridge bay operating instructions.

4.4 Check the left front locking ear is in its locked (up) position).

4.5 Clip release lanyard to release lever on left front lock.

4.6 Turn and secure the two rear guide ears to their side positions, lock in position using locking pin in foremost hole.

4.7 Turn front right locking ear down and secure.

4.8 Note: Bridge Bay is now locked to the BAP with winch hook and left front lock only and should not be mounted.

4.9 Engage vehicle PTO.

4.10 Adjust vehicle idle to approximately 1500 RPM.

4.11 Drive LHS hookarm and middle frame down and lock the winch frame to the bridge adaptor pallet by turning up and securing the two locking levers. Secure with safety pins.
Note there is 45 second delay before no transit circuit operates which will make connection impossible. If connection is difficult drive hookarm and middle frame down and try again.

4.12 Winch out approximately 30cm (1') of cable and remove hook from bridge bay. Winch in cable until flanges on hook lie lightly between cable guides and hook is clear of bridge bay.

4.13 Working from ground release bridge adaptor pallet frame locks by turning handle to up position.

4.14 Reverse vehicle to launch area until vehicle is correctly positioned for launch to take place.

4.15 Engage vehicle handbrake.

4.16 Operate vehicle bogie blocking or suspension lock-out if appropriate.

4.17 Raise front of bridge adaptor pallet using LHS hookarm, approximately 10cms (4") or until bay moves rearwards and bay is restrained by left locking ear.

4.18 Release bay when appropriate by pulling release lanyard. If bay will not move, raise BAP using extreme caution until it slides free.

4.19 Drive hookarm down.

4.20 Disengage bogie blocking or suspension lock out if appropriate.

4.21 Reduce engine idle speed to normal.

4.22 Manoeuvre truck from launch site.

4.23 Working from ground, lock BAP frame locks by turning spring loaded handles down on both sides.

4.24 Drive LHS hookarm and middle frame down and lock winch frame to hookarm of LHS by turning the two locking levers to their upmost position and securing the safety pins. Note again 45 second delay which will make connection impossible.

4.25 Turn front locking ears upwards and ensure release lever in left front locking ear is in its upwards position.

4.26 Unpin and rotate rear guide/locking ears to rearmost position and re-lock.

4.27 Disengage vehicle PTO.

4.28 Vehicle ready to drive.

CHAPTER 5

Controlled Launch of Bridge Bay

5.1 **Assuming bridge adaptor pallet and bridge bay are loaded on vehicle, reverse truck to launch area, halt 5m (5yds) short of water.**

5.2 **Engage vehicle handbrake.**

5.3 **Prepare bridge bay as per bridge bay operating instructions**

5.4 **Check that winch frame is engaged with LHS hookarm and the 2 locking levers are up and secured and hoses are connected.**

5.5 **Check the winch hook is attached and safely secured to the lifting eye of the bridge bay.**

5.6 **Working from ground check bridge adaptor pallet frame locks are locked.**

5.7 **Turn down front two locking ears by releasing spring loaded pins.**

5.8 **Rotate to rear guide/locking ears by removing locating pin. Lock the ears in their side position using the foremost hole.**

5.9 **Reverse vehicle to launch area and position vehicle for launching.**

5.10 **Engage vehicle handbrake**

5.11 **Engage vehicle PTO.**

5.12 **Adjust engine idle to approximately 1500 revs per minute.**

5.13 Operate bogie blocking or suspension lock-out system as appropriate.

5.14 Drive out hookarm cylinders by approximately 20cms (8").

5.15 Taking care that winch hoses do not get trapped drive out middle frame until front end of bay is almost on water surface.

5.16 Winch out cable until bay floats and unfolds and hook can be safely removed from lifting eye in the bay (it may be necessary to drive out middle frame further to disengage hook). Winch in cable until flanges of hook lie lightly in guides.

5.17 Bring in middle frame, then hookarm, to normal transit position.

5.18 Release bogie blocking or suspension lock-out as appropriate.

5.19 Reduce engine idle speed to normal.

5.20 Disengage vehicle PTO.

5.21 Remove vehicle from launch site.

5.22 Turn and secure front locking ears upwards.

5.23 Secure rear guide/locking ears in rear position.

5.24 Vehicle is now ready to drive.

CHAPTER 6

Retrieval

6.1 Assuming that bridge adaptor pallet is mounted on vehicle check that frame locks are securely locked.

6.2 Check the front locking ears are turned up and spring loaded pins are in correct position.

6.3 Check the release hook at front left locking ear is in it in its locked (up) position.

6.4 Check that rear guide/locking ears are turned to the rear position and secured.

6.5 Ensure that wide load signs etc are removed.

6.6 Reverse the vehicle to retrieval area, halt a few metres short of water.

6.7 Engage vehicle handbrake.

6.8 Engage vehicle PTO.

6.9 Adjust engine idle to approximately 1500 revs per minute.

6.10 Mount working platform and open control locker.

6.11 Check that winch frame is locked to LHS hookarm and the 2 locking levers are in their up position and secured with safety pins. Check hoses are connected.

6.12 Extend hookarm rams by approximately 20cms (8").

6.13 Ensuring that winch hoses do not become entrapped drive out middle frame until it is possible to reach hook from the ground. Winch out approximately 3m (3yds) of cable.

6.14 Lift cable hook clear of ground using middle frame.

6.15 Lower engine idle speed.

6.16 Reverse truck towards water to appropriate position for retrieval.

6.17 Engage vehicle handbrake.

6.18 Adjust vehicle idle to approximately 1500 revs per minute.

6.19 Operate bogie blocking or suspension locking as appropriate.

6.20 Using boat hook and/or bridge erection boat attach cable hook to lifting eye of bay, ensuring throat of hook faces upwards.

6.21 Adjust position of middle frame so that winch frame is approximately 3m (3yds) above water.

6.22 Winch in cable to move bay close to shore without lift/closing the bay.

6.23 If appropriate bridge erection boat to be used to keep bay in line with vehicle.

6.24 Ensuring that bridge bay is clear of personnel continue winching in cable until the bay is folded and automatically latches.

6.25 Winch-in cable until flange of hook lies within flanges of cable guide.

6.26 Bring in middle frame ensuring that the lower edge of the bay and tie down lugs will pass freely over rear roller at the BAP. Drive the hookarm rearwards intermittently so that the bay does not rise above the level of the rear bay guide ears.

6.27 When middle frame is fully down continue loading of bridge bay by bringing hookarm forwards.

6.28 Ensure bridge bay is fully forward and locked.

6.29 Release cable tension by unwinding approximately 2-5cms (1-2") of cable.

6.30 Check that all 4 bay locking gears are completely locked.

6.31 Release bogie blocking or suspension lock-out if appropriate.

6.32 Reduce engine idle speed to normal.

6.33 Disengage PTO.

6.34 Fit wide load signs as necessary, vehicle ready to drive.

CHAPTER 7

Handling of partially closed Bridge Bays.

The procedure for loading of bridge bays that are not fully closed due to mud or ice accumulation or battle damage is similar to that described in Chapter 6. However the Bay locks cannot be used and extra safety precautions are required.

7.1 **If during conventional retrieval some or all of the locking latches fail to operate. Carefully winch out cable so that bay starts to open then winch in again. If the latches still do not operate lift the front end of the Bay clear to the water.**

7.2 **If appropriate disengage bogie blocking and all suspension locking.**

7.3 **Reduce engine idle speed to normal.**

7.4 **Pull bay front end carefully ashore.**

7.5 **Ensure the Bridge Bay is parallel to vehicle. If not release cable hook and manoeuvre vehicle. Re-engage cable hook.**

7.6 **Engage vehicle handbrake.**

7.7 **Adjust engine idle speed to approximately 1500 Revs per minute.**

7.8 **Operate bogie blocking/suspension lock-out as appropriate.**

7.9 **Working from ground turn down and secure front locking ears.**

7.10 **Remove rear guide ears by removing both centre and locating pins. Secure pins back in their holes after removal using winch lift front bay and secure front end of bay with strap (safety precaution to ensure bay cannot open).**

7.11 Measure or estimate necessary extension for rear rollers.

7.12 Adjust rear roller width by removing and reinserting locking pins in appropriate holes.

7.13 Ensure that hookarm cylinders are approximately 20cm (8") extended.

7.14 Lift bridge bay using middle frame cylinders, ensure that lower edge of the bay and tiedown lugs will pass freely over rear rollers.

7.15 Continue loading using middle frame.

7.16 Check that bay side rails are positioned between flanges of the rear rollers, steer vehicle if necessary.

7.17 Drive middle frame down. Continue loading by driving hookarm fully forwards. Check that front end of bay is lying securely on front locking ears.

7.18 When bay is fully forward strap both ends of bay to bridge adaptor pallet using straps through appropriate locations on bridge adaptor pallet.

7.19 Retain cable tension.

7.20 Release bogie blocking and/or suspension lock-out if appropriate.

7.21 Reduce engine idle speed to normal.

7.22 Disengage PTO.

7.23 Fit necessary wide-load signs. Vehicle is then ready to drive.

CHAPTER 8

Unload bridge adaptor pallet with or without bridge bay.

8.1 **Engage power take-off and adjust vehicle idle to approximately 1500 Revs per minute.**

8.2 **Operate bogie blocking/suspension lock out if appropriate.**

8.3 **Working from the ground. Open bridge adaptor pallet frame locks.**

8.4 **Check front locking ears are up and secured.**

8.5 **Check that rear guide/locking ears are in their rear position and secured.**

8.6 **Mount operator's platform.**

8.7 **Disconnect the 3 winch hoses of the bridge adaptor pallet from the hookarm of the load handling system. The 2 larger diameter hoses first then the smaller. Reconnect to their securing locations on the winch frame.**

8.8 **Drive LHS hookarm and middle frame down and lock winch frame to the bridge adaptor pallet. Turn and secure the two locking levers down. Note 45 second delay before no transit circuit operates making connection impossible. If difficulty is experienced drive hookarm and middle frame down and try again.**

8.9 **Unload bridge adaptor pallet as per normal flatrack, ie ensure area behind bridge adaptor pallet is clear of personnel and using autosequenced or manual controls in unload direction unload bridge adaptor pallet (remember to operate hookarm cylinders first followed by middleframe if using manual mode).**

8.10 **Return hookarm and middle frame to normal transit position.**

8.11 **Reduce idle speed to normal.**

8.12 **Disengage bogie blocking or suspension lock-out if appropriate.**

8.13 **Disengage vehicle PTO.**

8.14 **Vehicle is now ready to drive.**

CHAPTER 9

Fast Water retrieval.

Extreme caution must be exercised at all times during fast water retrieval. The assistance of a suitable Bridge erection/Combat support boat aids this procedure. Preparations are conducted as per Chapter 6.

9.1 **Ensure that the cable hook is attached to lifting eye of bay. The bay is closed and secured.**

9.2 **Winch in cable until there is approximately 1m (1yd) of free cable between winch frame and bay.**

9.3 **Drive middle frame forwards carefully to bring front corner of bay into contact with the rear bumper of the BAP cross beam which will turn the bay parallel with the bridge adaptor pallet.**

9.4 **With the bay parallel to the bridge adaptor pallet and retained against it using cable tension drive the middle frame rearward and simultaneously winch the cable in keeping contact between the bay and the bumper using movement of the hookarm.**

9.5 **Continue winching until flange of hook lies lightly in the flanges of the cable guide.**

9.6 **Continue loading cycle by moving hookarm cylinders until they are extended approximately 20cms (3"). Continue loading using the middle frame, ensure that front corner of the bay is lifted between the rear guides of the bridge adaptor pallet.**

9.7 **Continue loading using the middle frame simultaneously moving the hookarm rearwards to keep the bay between the rear guides.**

9.8 **Remainder of loading cycle is carried out as per Chapter 6.**

CHAPTER 10

Vertical launch.

Vertical or highbank launch consists of two distinct phases.

The first phase being the off-loading of the bridge bay on to the ground and its preparation for launching.

The second phase being the move to launch site and launching.

Careful attention needs to be paid to the bank conditions prevailing, the following points in particular should be noted.

1. **The edge of the bank must be firm and solid particularly the area most adjacent to the edge, as the load of the truck and the bridge is predominantly on the rear most axle during launching.**

2. **The ground slope should be as low as possible and a maximum of approximately 12°.**

3. **The bank side should be as vertical as possible.**

4. **If any doubts as to the bank's firmness exist then the vehicle self-recovery winch should be used to anchor around a strong point or another vehicle connected using tow chains to ensure safe recovery of the vehicle and/or bridge bay, should the ground give way.**

Operating Sequence.

10.1 **Unload the bridge bay approximately parallel to the river bank. There must be sufficient area for manoeuvring the vehicle perpendicular to the bridge bay and the ground must also be suitable for reversing the unit to the bank.**

10.2 **Ensure bogie blocking is disengaged if appropriate.**

10.3 Manoeuvre vehicle so it is perpendicular to bridge bay approximately 2-3m (2·3yds) away.

10.4 Working from the ground rotate both front bay guides up.

10.5 Do not turn rear bay guide/locks rearwards.

10.6 Ensuring winch frame is locked to LHS hookarm, drive it rearwards so the winch frame is approximately 1.3m from the ground. Fit and secure the vertical launch extension beam using the mounting hooks and locking pin.

10.7 Fit the snatch block to the cable and clip the cable hook to the extension beam.

10.8 Check security of pulley on cable and hook to extension beam.

10.9 Drive hookarm cylinders fully in.

10.10 Using middleframe only lift snatch block approximately 2.5m (8') clear of ground.

10.11 Reverse vehicle close to bay ensuring rear bumper of BAP is parallel to bay.

10.12 Adjust engine idle to approximately 1000 RPM.

10.13 Operate bogie blocking if appropriate.

10.14 Taking care to ensure equal leg lengths, attach lifting slings to relavant pins on the bridge bay and secure centre of lifting sling tc snatch block hook.

10.15 Raise middle frame and tighten the cable using the winch so that the snatch block pulley is approximately 80cms (3') winch frame.

10.16 Tie a "Y" shaped bridle line to the bow tag line tie off on bridge bay.

10.17 Lift bay by winching in and open the roadway/bay fold lock latches at both ends and open the roadway/roadway pontoon travel latch at one end only.

10.18 Reverse vehicle to edge of bank.

10.19 Engage vehicle handbrake and anchor vehicle if considered necessary.

10.20 Pass end of bridle line to anchor point or boat moored upstream.

10.21 Lower bay into water by winching out cable and use tag line to keep bay in proper position. Note do not lower with middle frame.

10.22 Position bridge boat pushing knees against downstream end of bay and hold bay in position.

10.23 Pay out winch cable to slacken lifting slings and using boat hooks etc from bridge erection boat remove sling hooks, winch clear.

10.24 Using suitable lanyard on remaining closed roadway/roadway pontoon travel latch keeping free end of lanyard aboard bridge erection boat move boat clear of area required for unfolding bay.

10.25 Using extreme caution pull lanyard to actuate bay unfolding.

10.26 W/inch in cable.

10.27 Disengage bogie blocking if appropriate.

10.28 Remove vehicle from launch site.

10.29 Drive middle frame out until winch frame is approximately 1.3m (4') above ground.

10.30 Remove vertical launch gear ie snatch block and extension beam and secure in stowage locations.

10.31 Complete winching in of cable.

10.32 Return middleframe and hookarm to normal transit position.

10.33 Reduce engine speed to normal idle.

10.34 Disengage PTO.

10.35 Turn and re-secure front bay locking ears and rear guide ears.

10.36 Vehicle is ready to drive.

CHAPTER 11

Bridge Adaptor Pallet Lubrication

LUBRICATION ORDER

BAP

Item	Lubrication
Rear Rollers	Grease
Rear Middle Roller	Grease
Rear Bay Guide Ear Shafts (40mm (1.6")Dia)	Thinly Grease
BAP frame locking spring latch	Grease
Front locking ear spring latch	Grease
Front locking ear shaft	Oil
Release locking levers	Oil
A-frame of the BAP and LHS hook arm	
- - - - - - shafts	Oil
- - - - - - sockets	Grease
Winch cable	Clean and Oil
Winch Hook Housing	Oil
Cable Pulleys at the Winch	Grease
Cable Tensioner	Oil
Stowage box, hinges and latches	.. Oil

Distribution for Report No. 2513

Department of Defense

1 Director, Technical Information
Defense Advanced Research Projects Agency
1400 Wilson Blvd.
Arlington, VA 22209

1 Director
Defense Nuclear Agency
ATTN: TITL
Washington, DC 20305

2 Defense Technical Information Center
Cameron Station
ATTN: DTIC-FDAC
Alexandria, VA 22304-6145

Department of the Army

1 HQDA (DAMA-AOA-M)
Washington, DC 20310

1 HQDA (DALO-TSM)
Washington, DC 20310

1 HQDA (DAEN-RDL)
Washington, DC 20314

1 HQDA (DAEN-MPE-T)
Washington, DC 20314

1 Commander
US Army Missile Research and
Development Command
ATTN: AMSMI-PR
Redstone Arsenal, AL 35809

1 Director
Army Materials and Mechanics Research
Command
ATTN: AMXMR-RL (Technical Library)
Watertown, MA 02172-0001

1 Commander
Chemical Research R&D Center
ATTN: SMCCR-SPS (Technical Library)
Aberdeen Proving Ground, MD 21005

1 Commander
US Army Aberdeen Proving Ground
ATTN: STEAP-MT-U (GE Branch)

1 Director
US Army Materiel System Analysis Agency
ATTN: AMXSY-MP
Aberdeen Proving Ground, MD 21005-5071

1 Director
US Ballistics Research Laboratory
ATTN: AMXBR-OD-ST (STINFO)
Aberdeen Proving Ground, MD 21005-5066

1 Director
US Army Engineer Waterways Experiment Station
ATTN: Chief, Library Branch
Technical Information Center
Vicksburg, MS 39180

1 Commander
US Army Armament Research and
Development Command
ATTN: SMCAR-TSS
Dover, NJ 07801-5001

1 Commander
US Army Troop Support and Aviation Materiel
Readiness Command
ATTN: DRSTS-MES (1)
4300 Goodfellow Blvd.
St. Louis, MO 63120

2 Director
Petrol and Fld Svc Dept
US Army Quartermaster School
Ft. Lee, VA 23801

1 US Army Tank Automotive Command
ATTN: DRSTA-TSL
Warren, MI 48090

US Army Laboratory Command
1 ATTN: SLCMT-MN (M. Levy)
1 ATTN: SLCMT-MCZ (J. Wells)
Materials Technology Laboratory
Watertown, MA 02172-0001

1 Commander
US Army Electronics Research and Development Command
ATTN: DELSD-L
Fort Monmouth, NJ 07703-5301

1 President
US Army Aviation Test Board
ATTN: STEBG-PO
Fort Rucker, AL 36360

1 US Army Aviation School Library
PO Drawer O
Fort Rucker, AL 36360

1 HQ, 193D Infantry Brigade (Panama)
ATTN: AFZU-FE
APO Miami 34004

2 Special Forces Detachment, Europe
ATTN: PBO
APO New York 09050

2 Engineer Representative
USA Research & Standardization Group (Europe)
Box 65
FPO 09510

1 Commander
Rock Island Arsenal
ATTN: SARRI-LPL
Rock Island, IL 61299-7300

1 HQDA
ODCSLOG
DALO-TSE
Room 1E588, Pentagon
Washington, DC 20310-0561

1 Plastics Technical Evaluation Center
ARRADCOM, Bldg. 3401
Dover, NJ 07801

1 Commandant
US Army Engineer School
ATZA-CDD
Fort Belvoir, VA 22060

1 US Army AMCCOM
ATTN: Joseph Menke
1032 N. Thornwood
Davenport, IA 52804

1 Commander
Headquarters, 39th Engineer Bn (Cbt)
Fort Devens, MA 01433

1 President
US Army Airborne, Communications, and Electronics
ATTN: STEBF-ABTD
Fort Bragg, NC 28307

1 President
US Army Armor and Engineer Board
ATTN: ATZK-AE-PD-E
Fort Knox, KY 40121-5470

1 Director
ATTN: STSTO-TPP
Tobyhanna Army Depot
Tobyhanna, PA 18466-5097

1 Commander and Director
USA FESA
ATTN: FESA-TS
Fort Belvoir, VA 22060

1 HQ, USAEUR & Seventh Army
Deputy Chief of Staff, Engineer
ATTN: AEAEN-MT-P
APO New York 09403

1 Director
US Army TRADOC
Systems Analysis Activity
ATTN: ATAA-SL (Technical Library)
White Sands Missile Range, NM 88002

Director
US Army LABCOM/Ballistic Research Lab
12 ATTN: SLCBR-IB-B
10 Charles Leveritt
1 Jody Wojciechowski
1 Madeline M. Decker
Aberdeen Proving Ground, MD 21005-5066

Belvoir RD&E Center

Circulate

1 Commander STRBE-Z
Deputy Commander STRBE-ZD
Technical Director STRBE-ZT
Assoc Tech Dir (E&A) STRBE-ZTE
Assoc Tech Dir (R&D) STRBE-ZTR
Executive Officer STRBE-ZX
Sergeant Major STRBE-ZM
Advanced Systems Concept Dir STRBE-H
Program Planning Div STRBE-HP
Foreign Intelligence Div STRBE-HF
Systems and Concepts Div STRBE-HC
2 STRBE-J
8 STRBE-JBS
3 Tech Reports Ofc ASQNK-BVP-G
3 Security Ofc (for liaison officers) STRBE-S
2 Technical Library STRBE-BT
1 Public Affairs Ofc STRBE-I
1 Ofc of Chief Counsel STRBE-L

Department of the Navy

1 Director
Physics Program (421)
Office of Naval Research
Arlington, VA 22217

2 Commander
Naval Facilities Engineering Command
ATTN: Code 032-B
062
200 Stoval Street
Alexandria, VA 22332

1 US Naval Oceanographic Office
Navy Library/NSTL Station Bay
St. Louis, MO 39522

1 Library (Code L08A)
Civil Engineering Laboratory
Naval Construction Battalion Center
Port Hueneme, CA 93043

1 Director
Earth Physics Program
Code 464
Office of Naval Research
Arlington, VA 22217

1 Naval Training Equipment Center
ATTN: Technical Library
Orlando, FL 32813

3 Naval Sea Systems Command
ATTN: P. Schneider PMS377J1
Washington, DC 20362

1 Naval Air Development Center
ATTN: V. S. Agarwala, Code 6062
Warminster, PA 18974

3 David W. Taylor Naval Reseach Center
ATTN: A. G. S. Morton
Code 2813
Annapolis, MD 21402

Department of the Air Force

1 HQ USAF/RDPT
ATTN: Commander
Washington, DC 20330

1 HQ USAF/PREEU
Chief, Utilities Branch
Washington, DC 20330

1 HQ Air Force Engineering & Services Center
Technical Library FL7050
Tyndall AFB, FL 32403

1 US Air Force
Warner Robins Air Logistics Center
WR-ALC/MMEM
Warner-Robins AFB, GA 31098

1 Chief, Lubricants Branch
Fuels and Lubrications Division
ATTN: AFWAL/POSL
Wright-Patterson AFB, OH 45433