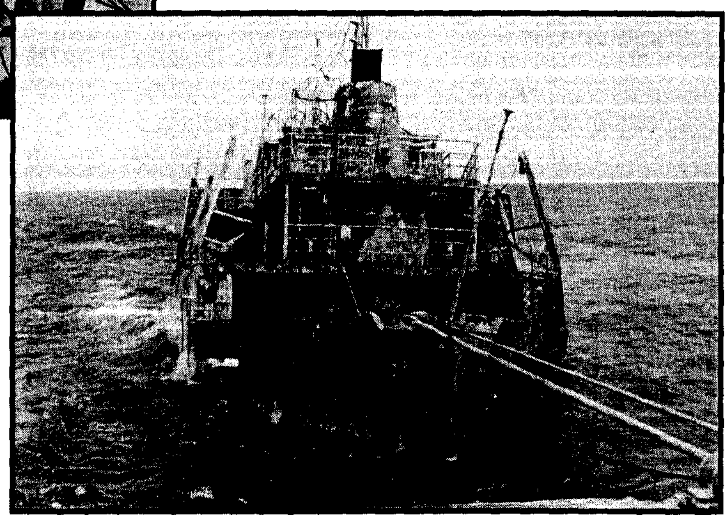
S0300-BS-RPT-010

0910-LP-489-0200

U.S. NAVY SALVAGE REPORT
M/V WENDY



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FEBRUARY 1994

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EXECUTIVE SUMMARY

On 27 January 1990, the Motor Vessel WENDY sunk in Coxen Hole Harbor, Bay Islands, Roatan, Honduras.

In June 1992, the Government of Honduras (GOH) approached the American Embassy in Tegucigalpa about the feasibility of United States assistance regarding the survey and removal of WENDY from Coxen Hole. The wreck was considered a threat to the environment and impeded economic development in the region.

On receipt of CINCLANTFLT tasking (Appendix S, CINCLANTFLT Norfolk VA 191542Z Jan 93), COMSUPPRON EIGHT issued Letter of Instruction (LOI) 93-005, Salvage Operation Bay Island, Roatan, Honduras (Appendix S, COMSUPPRON EIGHT 092025Z Feb 93) which established the following command relationship:

- Commander, Combat Support Squadron EIGHT would be the Operational Commander and On-Scene Commander during the salvage mission.
- Mobile Diving and Salvage Unit TWO (MOBDIVSALU TWO) would provide service as Salvage Master Diving Officer and provide divers and equipment as required.
- USS GRASP (ARS 51) would provide salvage services as stated in the salvage plan.

From January to April 1993 United States Navy Divers undertook the salvage of M/V WENDY, resulting in the detailed chronology of events below.

DATE	EVENT
27 January 1990	WENDY sinks in Coxen Hole Harbor, Roatan, Honduras
9-14 July 1992	Initial survey by COMSUPPRON EIGHT and NAVSEA 00C
15 August 1992	NAVSEA 00C completes oil removal from TULUM
19 January 1993	CINCLANTFLT tasking issued
24 January 1993	Second survey by COMSUPPRON EIGHT and MOBDIVSALU TWO
24 February 1993	Salvage plan promulgated
8 March 1993	Initial salvage team arrives in Roatan
10 March 1993	Lift barges arrive French Harbor, Roatan
7 April 1993	WENDY pulled up to shallow water
12 April 1993	WENDY pulled further into shallow water
21 April 1993	WENDY heavy lifted, turned over to GOH, disposed of at sea

For 45 days, COMSUPPRON EIGHT managed the salvage operation of the sunken ship WENDY from Coxen Hole Harbor, Roatan, Bay Islands, Honduras. The operation involved the efforts of the COMSUPPRON EIGHT Staff, USS GRASP (ARS 51) and 18 personnel from MOBDIVSALU TWO.

This report serves as a historical guide in conducting future wreck removal operations. This report discusses the command, structure, organization, salvage engineering, environmental concerns and operational aspects of this sunken ship removal operation. A myriad of organizational relationships envolved during the planning and execution of WENDY salvage, both internal to the Navy and with external government agencies. The salvage of the M/V WENDY was the largest, most technically difficult and politically sensitive foreign salvage operation conducted by the U.S. Navy in the last 20 years. It served as a tremendous training opportunity for the next generation of Navy salvors.

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CHAPTER 1

INTRODUCTION AND BACKGROUND SUMMARY

On 27 January 1990, the motor vessel WENDY sank in Coxen Hole Harbor, Roatan, Honduras. Figure 1-1 illustrates the general and detailed operation area. Figures 1-2 and 1-3 show Coxen Hole and the immediate vicinity. Figure 1-4 is a translated sinking report from the captain of the Port of Roatan. As stated, WENDY had been taking on water in the engine room for at least a day and the ship's master reported to port operations that the casualty was under control. Numerous rumors cloud the exact picture as to what really happened. However, it is believed that a dispute between the owners and crew developed and the ship was scuttled by the crew. This theory is supported by the lack of damage to the vessel and the failure to take appropriate action to save the vessel during the time of the casualty.

In early June 1992, the Government of Honduras (GOH) approached the American Embassy in Tegucigalpa about the feasibility of U.S. assistance with the survey and removal of three shipwrecks (the "WENDY," "TULUM" and "ALEXANDER") in Roatan, Bay Islands, Honduras. The wrecks were a threat to the fragile reef ecology and were considered an environmental hazard that also threatened the economy of the region.

During the period 9-14 July 1992 representatives from Combat Support Squadron EIGHT, Mobile Diving and Salvage Unit TWO and Naval Sea Systems Command (00C) were sent to Roatan to determine the feasibility of salvaging the three wrecks. This team developed a preliminary two-phase plan for salvage of the Bay Island wrecks. Phase One involved the removal of 25,000 gallons of heavy bunker oil from "TULUM" in order to stop the immediate danger to the environment. Phase Two was to remove the wrecks.

Phase One of the operation commenced on 31 July 1992 by NAVSEA (00C). Oil cleanup was successfully concluded on 15 August 1992.

The GOH indicated that their priorities for Phase Two were as follows: 1) Removal of "WENDY" from Coxen Hole Harbor, 2) Salvage of "TULUM" from atop the barrier reef, and 3) Remove "ALEXANDER" from the beach. It was determined that the salvage of "WENDY" and "ALEXANDER" were within fleet capabilities and salvage of "TULUM" should only be attempted after the successful salvage of the other wrecks and only under ideal conditions.

During January 1993, CINCLANTFLT made the decision that time and assets were available to salvage one of the Roatan shipwrecks. Based on GOH priorities salvage of the sunken ship "WENDY" was scheduled.

1-1 TASKING AND MAJOR MILESTONES

An initial diving survey was conducted 6 June 1992 by a team of Navy Special Warfare personnel from NAVSPECWARUNIT EIGHT. Based on their initial findings, the American Embassy, Honduras began to lobby for removal of the wrecks as a possible "civic action" to be conducted in conjunction with the Honduran military. NAVSPECWARUNIT EIGHT personnel determined the operation was beyond the scope of their capabilities and fleet salvage divers would be required to complete the task. The American Embassy indicated the GOH would appropriate funds for the initial feasibility study and any subsequent salvage efforts.

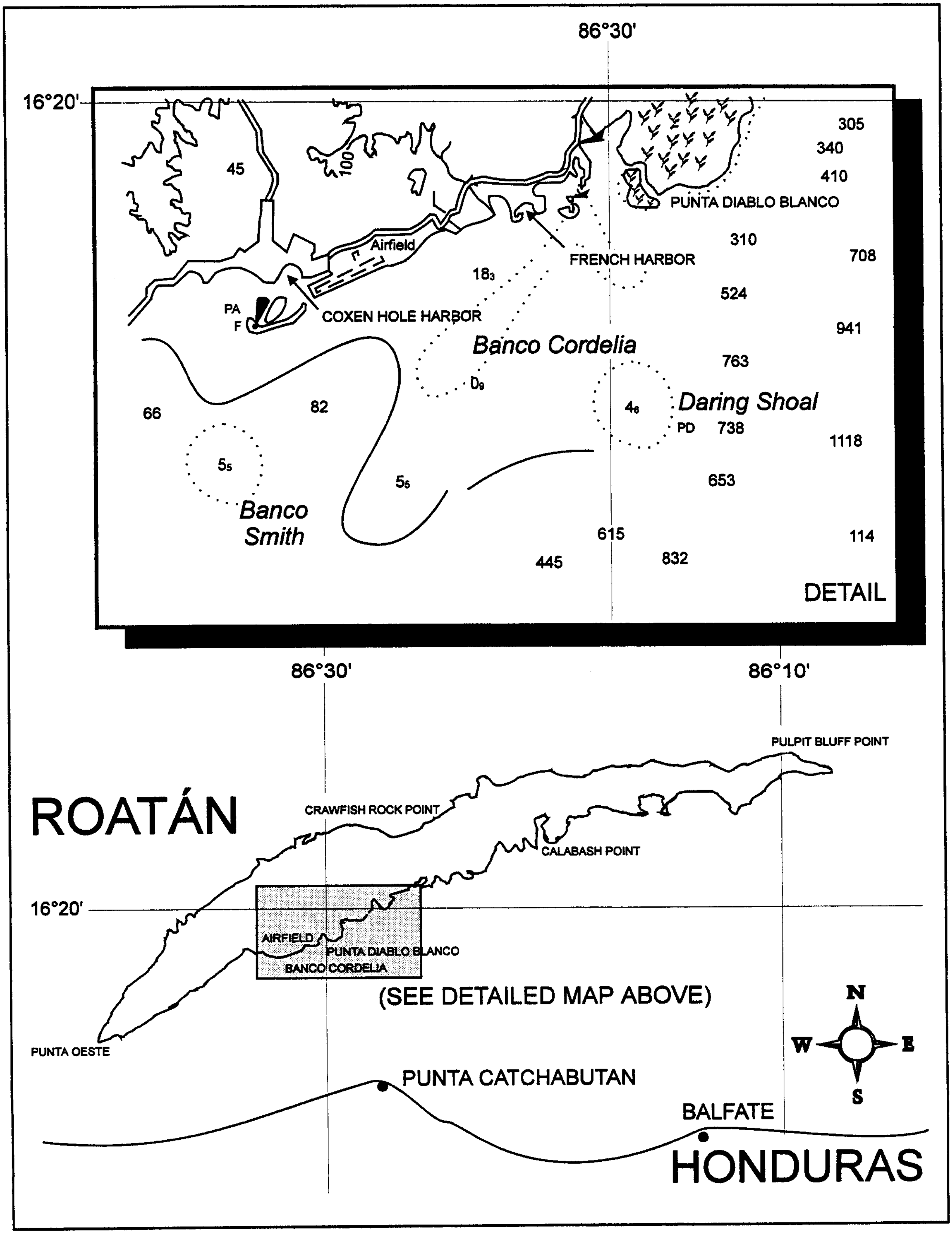

Figure 1-1. Operations Area.

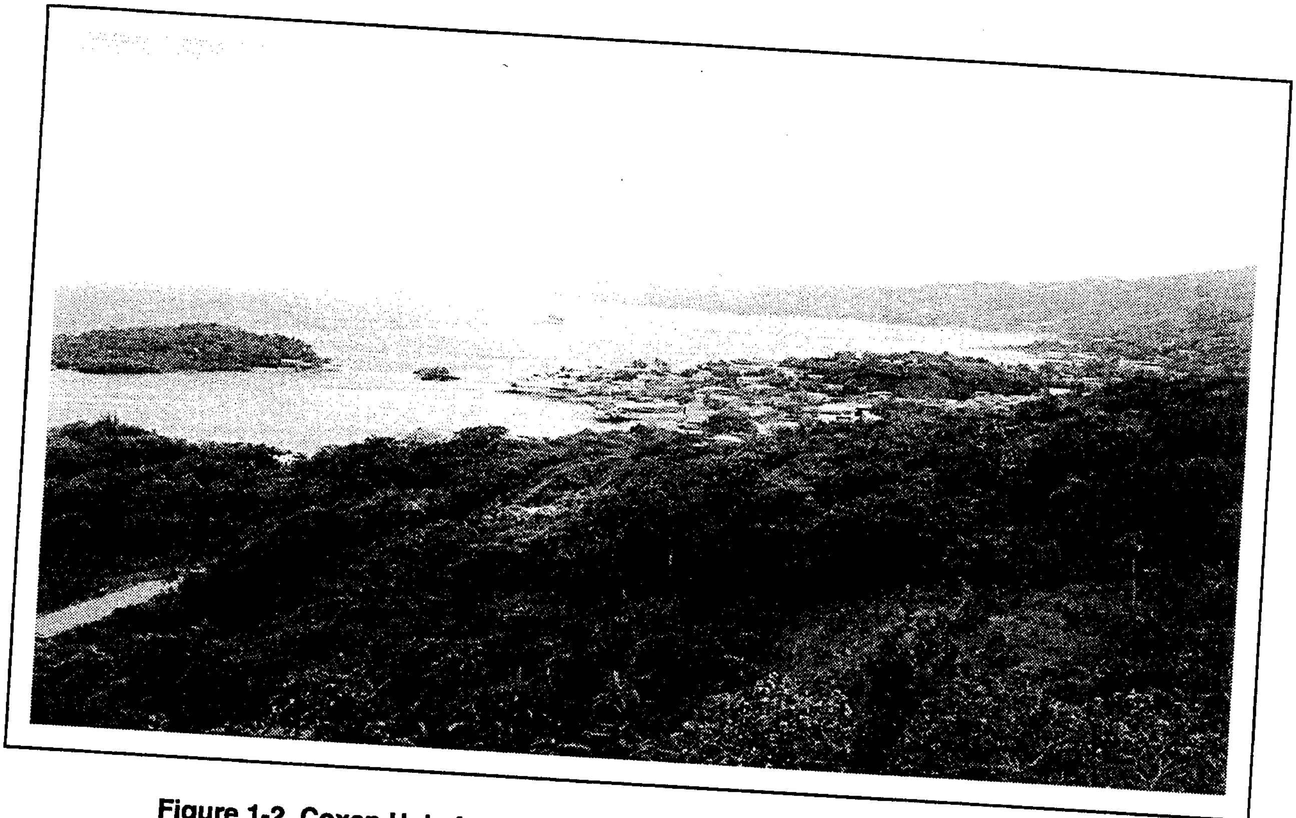

Figure 1-2. Coxen Hole from the Airport Control Tower Looking Westward.

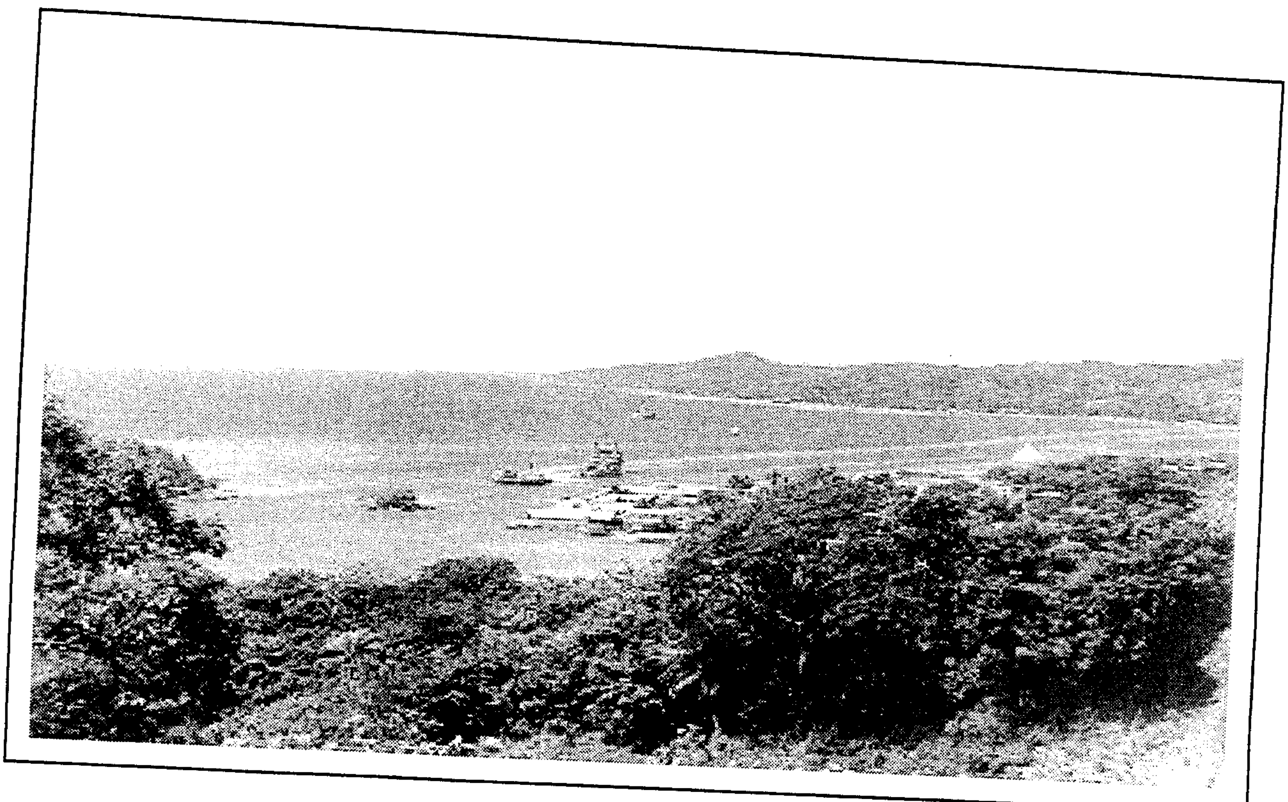

Figure 1-3. Coxen Hole from the Airport Control Tower Looking Westward.

WENDY Sinking Report

January 27, 1990

SUBJECT: SINKING REPORT

TO: SUPERINTENDENT NATIONAL MERCHANT MARINE
TENIENTE DE NAVIO
SANTIAGO VELASQUEZ ALVARADO

This is to inform you that on January 26, 1990 at approximately 1730, the M/V WENDY, Honduran flag, 755 net tons, was observed to have a certain degree of list. Such vessel was anchored in the channel next to the entrance of the city pier of Coxen Hole, Roatan. The crew of the vessel was immediately alerted. The vessel, which departed from the port of Tela, came into Roatan on December 22, 1989 due to mechanical problems. It was carrying a shipment of waste cardboard. The manifest did not describe the breakdown of the cargo; the departure authorization only described it as "bundles."

On January 26, 1990, at 2000, the captain of the WENDY, Magnus de Roche, a British citizen, arrived to the office of the Captain of the Port to report that his ship was taking in water in the engine room bilges, but that he was in no need of help because he had bilge pumps operating. The office of the captain of the Port was then standing by for any changes in the situation and requested help from the owners of the ship with no luck since they were in Tegucigalpa at the time. Then the Naval Base of Puerto Castilla was informed about the situation; LT Eduardo Espinal Paz achnowledged.

On January 27, 1990 at 0800, the Captain of the WENDY arrived again to the Captain of the Port and reported that he could not do anything else to save the vessel and that they urgently needed help. At this time the ship had a major list to the starboard side. The Captain of the Port immediately proceeded to call the Naval Base of Puerto Castilla and request assistance.

At 0900 the same day, the captain and crew of the WENDY abandoned the ship.

At 1200 the Honduran Navy patrol boat TEGUCIGALPA, commanded by LTJG Guillermo Amaya, arrived to the City Pier of Coxen Hole, Roatan.

At 1400 a rescue attempt was made. Some of the electronic equipment was salvaged with the cooperation of the TEGUCIGALPA; however, approximately 4,000 gallons of diesel fuel were not removed from the WENDY. Hopefully this fuel can be retrieved since it represents a great pollution risk to the marine environment of the area.

The electronic equipment salvaged from the WENDY is the following: 1-liferaft, 1-FURUNO radar serial # 852-0016, 1-firefighting equipment, 2-searchlights (one is broken), 1-master gyro compass & 2 repeaters, 4-liferings, 1-set of binoculars, 1-FURUNO LORAN, 1-internal comm radio, 1-VHF radio, 1-sextent, 3-CO_2 fire extinguishers, 1-dry and wet bulb thermometer set, 1-radio direction finder and 1-lifeboat.

The folowing is the list of the crew of the WENDY:

	NAME	NATIONALITY	POSITION
1	Magnus de Roche	Great Britain	Captain
2	Charles de Roche	St. Vincent	1st Mate
3	Claude Petit	Martinique	Chief Engineer
4	Paul Latchman	Guyana	2nd Engineer
5	Kisshoor Latchman	Guyana	Quartermaster
6	Andre Butchey	Guyana	Sailor
7	Clarence Clarke	St. Lucia	Sailor
8	Terrance Daniel	St. Lucia	Cook
9	Kendrick T. Kidd	St. Vincent	Cook
10	Cano B. Bodden	Honduras	Chief Mate
11	Modesto E. Garcia	Honduras	Cook

Respectfully,
LT (Ret) Oscar Bustillo Castellanos
Captain of the Port of Roatan

Figure 1-4. Translated Sinkage Report for M/V WENDY.

During 9-14 July 1992 a second team of U.S. Navy personnel conducted a salvage feasibility survey. The team consisted of personnel from COMSUPPRON EIGHT, Mobile Diving and Salvage Unit TWO and Supervisor of Salvage (NAVSEA 00C). Upon completion of the salvage survey a salvage plan was subsequently developed.

On receipt of CINCLANTFLT tasking (Appendix S, CINCLANTFLT Norfolk, Va 191542Z JAN 93), COMSUPPRON EIGHT issued LOI 93-005, Salvage Operation Bay Island, Roatan, Honduras (Appendix S, COMSUPPRON EIGHT 092025Z FEB 93) which established the following command relationship:

(1) Commander Combat Support Squadron EIGHT would be the operational commander and on-scene commander during the salvage mission.

(2) Mobile Diving and Salvage Unit TWO would provide service as salvage master, diving officer and provide divers and equipment as required.

(3) USS GRASP would provide salvage services as delineated in the salvage plan.

The initial salvage plan offered two alternatives for the ultimate disposal of "WENDY." Both alternatives consisted of using heavy lift barges to raise "WENDY" off of the bottom with a series of lifts, then patch and pump dry and re-float once in shallow water. The first option would dispose of "WENDY" offshore, the second option would dispose of "WENDY" locally.

Disposal of "WENDY" and final selection of salvage options developed into an environmental issue that took extensive effort by the American Embassy and USDAO, Honduras to eventually resolve. Although the exact final disposal location was not decided until 20 April 1993, the day before "WENDY" was actually moved out of the harbor, the decision was made to dispose of "WENDY" offshore prior to commencing the operation. Table 1-1 provides a chronology of major events in the operation.

Table 1-1. Major Events During Operation.

Date	Event
27 January 1990	WENDY sinks in Coxen Hole Harbor, Roatan, Honduras
9-14 July 1992	Initial survey by COMSUPPRON EIGHT and NAVSEA 00C
15 August 1992	NAVSEA 00C completes oil removal from TULUM
19 January 1993	CINCLANTFLT tasking issued
24 January 1993	Second survey by COMSUPPRON EIGHT and MDSU-2
24 February 1993	Salvage plan promulgated
8 March 1993	Initial salvage team arrives in Roatan
10 March 1993	Barges arrived French Harbor, Roatan
7 April 1993	WENDY pulled up to shallow water
12 April 1993	WENDY pulled further into shallow water
21 April 1993	WENDY heavy lifted and disposed of at sea

1-2 SCOPE OF COMSUPPRON EIGHT MISSION

For 45 days, COMSUPPRON EIGHT managed the salvage operation of the sunken ship "WENDY" from Coxen Hole Harbor, Roatan, Bay Islands, Honduras. The operation involved the efforts of the COMSUPPRON EIGHT staff, USS GRASP (ARS 51) and 18 personnel from Mobile Diving and Salvage Unit TWO.

1-3 PURPOSE OF REPORT

This report will serve as a historical guide in conducting future wreck removal operations. This report discusses the command, structure, organization, salvage engineering, environmental concerns and operational aspects of this sunken ship removal operation. A myriad of organizational relationships evolved both internal to the Navy and with external government agencies. These organizations had to be advised on all major facets of the planning, operations and environmental considerations. Further, the salvage operation served as a tremendous opportunity to train the next generation of Navy salvors.

CHAPTER 2

COMMAND AND ORGANIZATION

The command organization and resulting control over the day-to-day operations are depicted in Figure 2-1.

2-1 ORGANIZATION OF THE SALVAGE TEAM

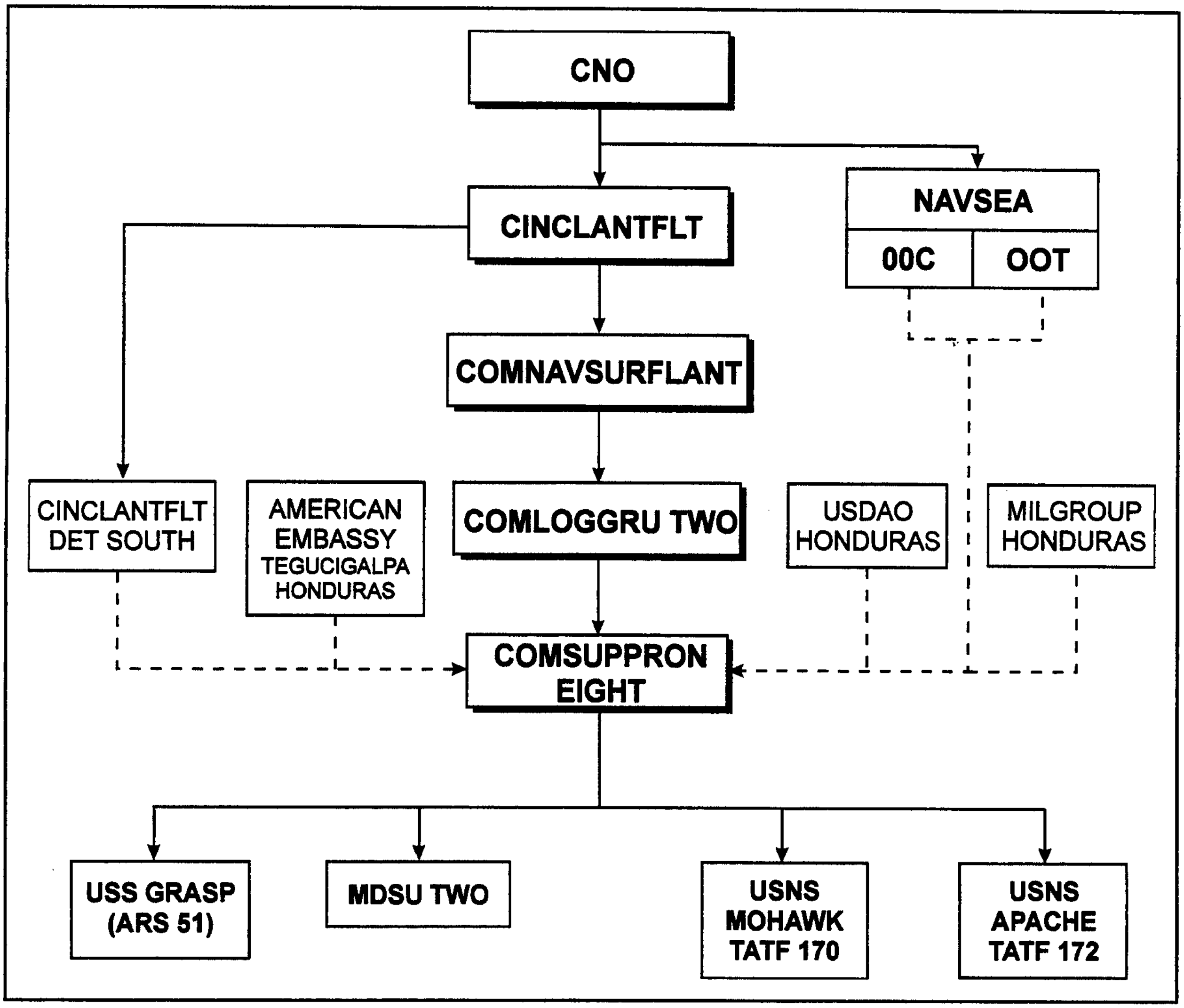

Figure 2-1. Chain of Command for M/V WENDY Salvage.

CINCLANTFLT tasked COMSUPPRON EIGHT with the specific responsibility of removing WENDY from Coxen Hole Harbor. Consequently, COMSUPPRON EIGHT assumed duties as operational commander and on-scene commander. COMSUPPRON EIGHT developed a thorough salvage plan based on the option selected by AMEMBASSY, Honduras. Squadron assets were selected and assigned in accordance with the initial salvage plan.

2-2 SUPPORTING FORCES

2-2.1 Vessels

USNS MOHAWK (T-ATF 170): Tasked to tow the YC and YFN from NAB Little Creek to Roatan, Honduras. Both barges were completely loaded with the equipment and material required to accomplish the mission. A team of salvors from MDSU TWO embarked onboard USNS MOHAWK to escort the equipment and commence the initial phase of the operation upon arrival at Coxen Hole, Roatan.

USS GRASP (ARS 51): Selected to be the primary salvage platform for the operation. USS GRASP arrived on station 17 March 1993 and became the hub of the salvage job. USS GRASP provided the following services:

- Messing and berthing
- Twenty divers
- 40-ton boom lifting capability
- Heavy lift platform
- 70-ton bollard pull capability
- Communication center
- Manufacturing and repair capabilities to support salvage operations

USNS APACHE (T-ATF 172): Tasked to tow two barges loaded with salvage equipment from Roatan to NAB Little Creek. USNS APACHE was sent to Roatan to perform this mission because USS GRASP had to return to other operational commitments before the barges were ready for tow.

2-2.2 Other Navy Units

Combat Support Squadron EIGHT. Tasked as operational commander and on-scene commander. Developed the salvage plan and provided all engineering analysis. Coordinated all aspects of the salvage, logistics, and wreck removal/disposal.

Mobile Diving And Salvage Unit TWO. Tasked to provide diving officers, salvage master and a deployable dive team with all equipment required to conduct the salvage operations as directed by the on scene Commander.

2-2.3 Other Military Units

Military Group, Honduras. Provided logistical and political support for the operation. From the early planning stages of the operation, MILGROUP, Honduras was an essential part of the mission. They were the liaison between U.S. Navy units and the Honduran military.

USDAO Honduras. Provided logistical and political support for the operation. USDAO became the primary logistical coordinator for the mission. Established husbanding services, performed military liaison duties, set up mail service, handled emergency leave cases and determined the final disposal location of WENDY.

2-2.4. State Department

American Embassy, Tegucigalpa, Honduras: Primary driving force behind the execution of the mission. AMEMBASSY initiated the request for the salvage services, procured and handled money appropriated by the GOH and provided political support throughout the entire mission.

2-2.5. Honduran Military

Environmental and Tourism Office, Roatan, Bay Islands, Honduras: Provided a local command post for the entire operation. The operational supervisors were provided shore-based office space and telephone service by this group.

Honduran Military Representative: ENS Dennis Chinchia performed this task for the Honduran Navy. Chinchia was an essential member of the salvage team and primary liaison with Honduran military and local inhabitants.

2-2.6. Honduran Civilians/Contractors

Albert Jackson. Owner of Jackson Shipping, Inc. and Fantasy Island Beach Resort. Tasked the managers of his facilities to assist the U.S. Navy as required during the salvage operation.

Bob Webster. Manager of Fantasy Island Beach Resort. Coordinated locally-provided messing and berthing.

Robert McNab. Manager of Jackson Shipping, Inc. Husbanding agent for all locally-procured goods and services.

Bob McNab. President of B&S Fishery. Provided pilot and tug services.

Luey McLaughlin. Owner of Half Moon Bay Cabins and Blue Seas Seafood. Provided messing, berthing, tug and pilot services.

Kirby Kirkconnel. Tug and pilot services.

Alan Hyde. Owner of Hyber Shipping. Provided fresh water and barge services.

CHAPTER 3

SALVAGE PLAN AND ENGINEERING

3-1 INTRODUCTION

The salvage of the WENDY was executed in five phases as summarized in Table 3-1.

Table 3-1. Salvage Phase Summary.

Phase	Operation	Duration
1	Pre-Deployment and Initial Plan Ship Modeling Cargo Modeling Barge Configuration Salvage Plan	9 July 92 thru 8 March 93
2	Rig WENDY for Heavy Lift/Refloating Running Cables Float Plan Superstructure	9-17 March 93
3	Pull to Shallower Water Compartment De-Watering Beach Gear Pulling Barge Configuration Heavy Lift Barge Configuration USS GRASP Pull Configuration	18 March 93 thru 12 April 93
4	Heavy Lift of WENDY Bow Lifting Barges WENDY Configuration Pivot Forward Bow Lift Barge Heavy Bow Lift USS GRASP Heavy Bow Lift	13-19 April 93
5	WENDY Removal WENDY Configuration Barge Configuration USS GRASP Configuration Retraction Tow	18-21April 93

During the FIRST PHASE, several trips to Roatan were made to obtain as much information regarding the WENDY as possible. POSSE was then used to model the problem and an initial salvage plan was developed. The SECOND PHASE consisted of refining the POSSE model and the initial attempts to salvage the WENDY by means of heavy lift. When the heavy lift method appeared to be lacking sufficient progress, the THIRD PHASE of the salvage evolution was initiated which resulted in dragging the WENDY into shallower water. The first part of PHASE THREE utilized three legs of beach gear and a barge rigged as a pulling platform. WENDY was dragged about 200 feet which put her stern clear of the water. The engine room and aft compartments were then de-watered. The second part of PHASE THREE used the same barge rigged with two sets of beach gear and the third set of beach gear was run to the USS GRASP. WENDY was pulled an additional 20-30 feet during this last attempt at dragging her. As it seemed unlikely that any significant progress would be gained by attempting to pull WENDY any further up the beach, PHASE FOUR, the heavy bow lift of WENDY was attempted. PHASE FOUR failed to produce any positive results due to the inability to de-water the forward compartments and also the failure to produce sufficient lift from the barges and USS GRASP. The final phase, PHASE FIVE, utilized a barge as a heavy lift over the bow of WENDY and the pumping of all aft compartments to produce sufficient buoyancy to float WENDY free and dispose of her at sea. This proved successful and the removal of WENDY from the harbor was completed.

3-1.1 POSSE. The majority of the engineering calculations performed during the preparation and actual salvage of WENDY were performed using the *Program of Ship Salvage Engineering (POSSE)*. This was the first use of POSSE on a sunken wreck removal operation.

POSSE's detailed analysis mode bases hydrostatic and stability calculations on a numeric hull model defined by offsets and lightship and cargo weight distributions.

Offsets may be obtained from stored hull data files or entered manually from hull plans, damage control plates, actual measurements, extrapolation from similar hull types or a combination of these four methods.

Weight distributions can be obtained from damage control books, shipping manifests and logs, compartment inspections, estimates based upon similar hull configurations or a combination of these four methods.

Obviously, the accuracy of each of these methods is dependent upon the damage incurred to the vessel and the reliability of the method itself. In the case of WENDY, actual measurements and a partial set of damage control drawings were all that were available. As a result, many assumptions and estimations were made which were continuously refined as the salvage progressed.

POSSE proved to be invaluable during the salvage as what-if scenarios and revisions to the model based upon better information were conducted in real time. Although POSSE was and is considered an invaluable asset during any salvage, it must always be used with engineering insight in order to prevent the salvage effort from proceeding on a course leading to real time disaster.

Printouts from the POSSE data files for WENDY at the various stages of the salvage operation are discussed in the following sections and provided in detail in Appendices G thru M.

3-2 PHASE I: PRE-DEPLOYMENT AND INITIAL PLAN

3-2.1 Ship Modeling. Modeling of the vessel progressed through several phases. The initial phase consisted of developing a very rough model from which to get a feel for the overall problems and to identify what additional information would be required to further develop the salvage plan. The following phases continued to refine the model based upon new and corrected information.

3-2.1.1 Hull. During the initial fact finding trip to Roatan from 9-14 July 1992, divers measured the overall length, depth and beam at 30-foot intervals. An initial hull model (Appendix G) was developed using POSSE and inputting the hull form for a general cargo vessel, given in Principles of Naval Architecture[1]. The hull form was then scaled to the dimensions obtained by the divers. This model was used in the initial feasibility study to determine the general ship characteristics, to provide insight for developing the initial salvage plans and to determine what basic equipment and preparations would be required to prepare for the various salvage options developed.

1. Principles of Naval Architecture, Society of Naval Architects and Marine Engineers, New York, NY, 1980

The second fact finding trip to Roatan from 24-29 January 1993 yielded some additional information as to the ship's builder and some water-logged plans. These plans were in very poor condition and provided only a few jigsaw puzzle pieces of information. The most valuable was an intact view of the ships mid-section. By using the original name of the ship "RAAMGRACHT," which was welded in raised letters on the hull, NAVSEA 00C was able to determine the ship's builder from Lloyds of London files. The building yard, Pattje Shipyard Waterhuizen (Groningen), Holland, was contacted but they had destroyed all records of this class of ship several years before and were unable to provide any information concerning the ship's design or configuration.

The trip to Honduras and Roatan from 7-12 February 1993 to brief the Honduran President on the intended salvage plan resulted in obtaining a copy of the ship's damage control plans (Appendix Q). These plans provided a reasonable compartment layout and hull form. The POSSE program was used again to re-configure the hull model based upon the damage control plans, the portion of the ship's plans showing the mid-section and the measurements taken by the divers the year before. With the exception of the stern area in the vicinity of the propeller, the hull model (Appendix H) appeared to be a very accurate representation of the actual hull form and required no additional modification during the remaining salvage period.

3-2.1.2 Compartment Layout. The first information obtained regarding the ship's compartment layout was obtained from a sketch (Figure 3-1) obtained from NAVSPECWARUNIT EIGHT who performed the initial survey of the wreck in 1992. As it was not to scale and provided no dimensions or reference points, it provided a source from which only an engineer's eye could be used to develop the models compartment layout. This compartment data was used in the initial 1992 model (Appendix G) only.

The damage control plans obtained during the February 1993 trip (Appendix Q), provided the first real indication of how the ship's compartments were laid out. The resulting compartment model was relatively accurate and was modified only after divers completed the initial survey of the engine room compartment during the salvage of WENDY itself.

The major concerns for the salvage of WENDY were the free surface contributions from the engine room and especially the cargo compartment. The cargo compartment had a 155 foot length and a 35 foot beam. The concern for the free surface affect resulting from this compartment drove the initial salvage plan to consider only two alternatives. First, heavy lift WENDY in the submerged condition to a disposal site or second, drag WENDY up the beach to maintain stability due to ground reaction until the cargo compartment could be de-watered.

3-2.1.3 Lightship. The initial 1992 model (Appendix G) lightship displacement was estimated to be 600 tons based upon engineering judgment. This weight distribution was only used to obtain a feel for the lift requirements to be encountered during the salvage.

As there was no data obtained which provided a value for the lightship weight and distribution, POSSE was used to determine the lightship weight and distribution for the final model. To do this, the hull characteristics developed from the POSSE DETAILED hull model were input back into the POSSE RAPID model. The remaining parameters, service speed and ship type, were varied until a maximum value was obtained. The maximum value (400 tons) was then used during the analysis. A lightship displacement of 400 tons appeared to be confirmed by a report on the sinking provided by the Coxen Hole port authorities (Figure 1-2) which indicated a net displacement at the time of the sinking of 755 tons. This agreed fairly closely with the 836-ton (not including salt water ballast) total displacement provided by POSSE (Figure 3-2) which included the reported fuel and cargo.

As it turned out, the lightship weight was actually closer to 800 tons. This error was not realized until several unsuccessful attempts had been made to drag WENDY into shallower water under conditions that

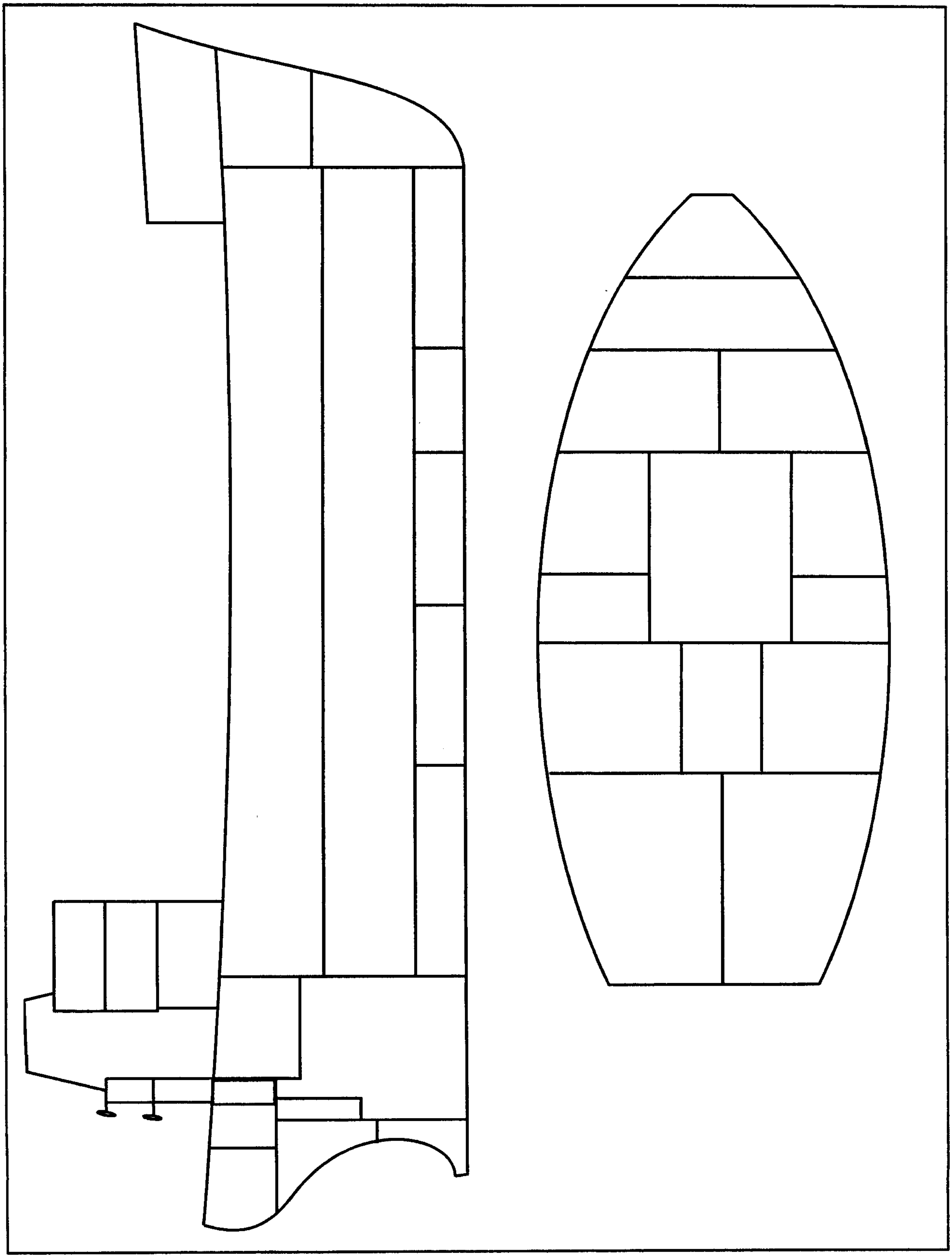

Figure 3-1. Layout of the WENDY'S Compartments.

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FREIGHTER -- WENDY  (SINKING on 1989)                    OOC POSSE-LOAD V1.00
Rev. 0  (by: GAP)                                                  02-24-1993

                     TRIM & STABILITY SUMMARY

                    WEIGHT      KG        LCG       TCG       FSmom
ITEM                LTons     ft-BL     ft-AP     ft-CL    ft-LTons
-------------------------------------------------------------------
Light Ship          400.0    13.000    59.000F    0.000
Constant              5.6     2.986     8.624F    0.000        1.5

Bulk Cargo          400.0    13.000   120.000F    0.000
Misc. Weight          0.0     0.000   107.025F    0.000        0.0

Diesel Oil           17.6     3.764   113.152F    0.000      291.3
Fresh Water          13.1     1.944    92.533F    0.000       35.0
SW Ballast          336.7     2.317   117.113F    0.000      447.5
-------------------------------------------------------------------
TOTALS            1,173.0     9.624    97.426F    0.000      775.2


STABILITY CALCULATION            TRIM CALCULATION
 KMt              15.239 ft       LCF Draft             8.578 ft
 KG                9.624 ft       LCB (even keel) 107.39 ft-FWD
 GMt               5.615 ft       LCF             103.446 ft-FWD
 FSc               0.661 ft       MT1in                 140 ft-LT/in
 GMt  Corrected    4.955 ft       Trim                6.938 ft-AFT
                                  Prop. Immersion       148 %
                                  List                 0.00 deg

DRAFTS
  A.P. 11ft-11.17in ( 3.637m)        Aft Marks 11ft-11.17in ( 3.637m)
  M.S.  8ft- 5.55in ( 2.579m)        M.S.Marks  8ft- 5.55in ( 2.579m)
  F.P.  4ft-11.92in ( 1.522m)        Fwd Marks  4ft-11.94in ( 1.522m)
```

Figure 3-2. Trim and Stability Summary.

should easily have moved her. NAVSEA OOC, consulting with the program developer, was informed that the empirical relation used in the RAPID calculation does not hold for ships under 400 feet in length. A revised lightship weight estimate of 800 tons was obtained and the POSSE model was updated accordingly. The calculations provided by POSSE during the remainder of the salvage operation were in very close agreement with the observed conditions. This problem has since been proposed to be resolved in an updated version of POSSE.

3-2.2 Cargo Modeling. The shipping company which had operated WENDY was unable to provide any information regarding the type and quantity of cargo onboard. Also, no deck logs or engineering logs were found which could provide assistance in loading the vessel's tanks. As such, many assumptions and estimates were made to load WENDY in such a manner as one would expect for a ship in her condition. Whenever any information could be found, it was readily used. An in-depth analysis of the cargo is presented in Appendix C.

3-2.2.1 Cardboard. Once the cargo compartment volume was determined, an estimate of the cargo displacement could be made. Volume 1 of the Salvage Manual[2] provided an estimated cargo density for packaged cardboard of 210 cubic feet per ton. Based upon a fully loaded cargo hold, the maximum estimated weight of the cargo dry was 410 tons. The Coxen Hole port authorities reported numerous bails of cardboard had floated away during the sinking. The cargo was also reported to have included lumber of an unknown quantity. Divers gaining access to the forward cargo shelter reported finding a relatively small quantity of timbers and other lumber products, most of which were floating in the overhead of the compartment. Therefore, a value of 400 tons was used in all calculations requiring a dry cargo weight.

To determine the weight of the cargo under water, an attempt was made to weigh the cargo under water using a large 300 pound fish scale and lifting straps. Although this attempt failed due to the straps slicing through the cardboard bails, an understanding of the cardboard's condition was obtained. The bails dimensions were roughly 28x36x94 inches. A diver was able to move and partially lift a bail during the attempt to sling the bail. As shown in Appendix C, a dry weight of 650 pounds per bail was calculated. Based upon the diver's estimates, an underwater weight of 150 pounds per bail was used. This equates to a 100-ton total cargo weight under water. Based upon the lift required by the barges to raise the bow section and continued verification throughout the salvage of the POSSE model, it would appear that the estimate was reasonable.

3-2.2.2 Fuel/Water/Miscellaneous. The only information obtained to quantify the liquid loading present onboard WENDY was the port operations sinking report (Figure 1-2) stating that 4,000 gallons of fuel was present onboard at the time of sinking. The remaining liquid loading levels were estimated based upon expected trim and loading conditions for a crew and voyage scenario under which WENDY was operating. Appendix H presents the final loading condition assumed for WENDY. Due to the presence of vents on all tanks and the information that the ship had been scuttled, the remaining volume in all the tanks that was not occupied by cargo was assumed to be filled with sea water.

3-2.3 Barge Configuration.

3-2.3.1 General. Early in the salvage preparation process, it was determined that some platform(s) would be required to support all the pumping equipment, beach gear and scrap. Later, when the salvage plan developed, additional requirements were identified which included heavy lift, beach gear support, transport of equipment to Roatan and additional work area for the salvage teams. It was determined that the best qualified and most economical platforms available that met all these requirements were barges. Excess barges were identified and obtained courtesy of Naval Weapons Station, Yorktown, Virginia. Figure 3-3 shows the two barges, in tow behind the USNS MOHAWK, arriving off of French Harbor, Roatan, Honduras.

The heavy lift capability of the barges was one of the most important aspects to be addressed in preparation for the salvage. With each barge capable of supporting a load of 550 tons, a method was required to take advantage of this lifting capacity without damaging the barges or creating a stability problem. POSSE was used to create a model of the barges from their plans (Appendix N). Several loading conditions were then analyzed and it was determined that the barges could be ballasted down in a controlled fashion to their maximum design displacement by flooding pairs of tanks symmetrically without endangering the stability of the barges. Structural modifications were then designed and installed to strengthen each barge and provide attachment points to handle the expected loading conditions.

2. U.S. NAVY Salvage Manual, Vol. 1, Stranding

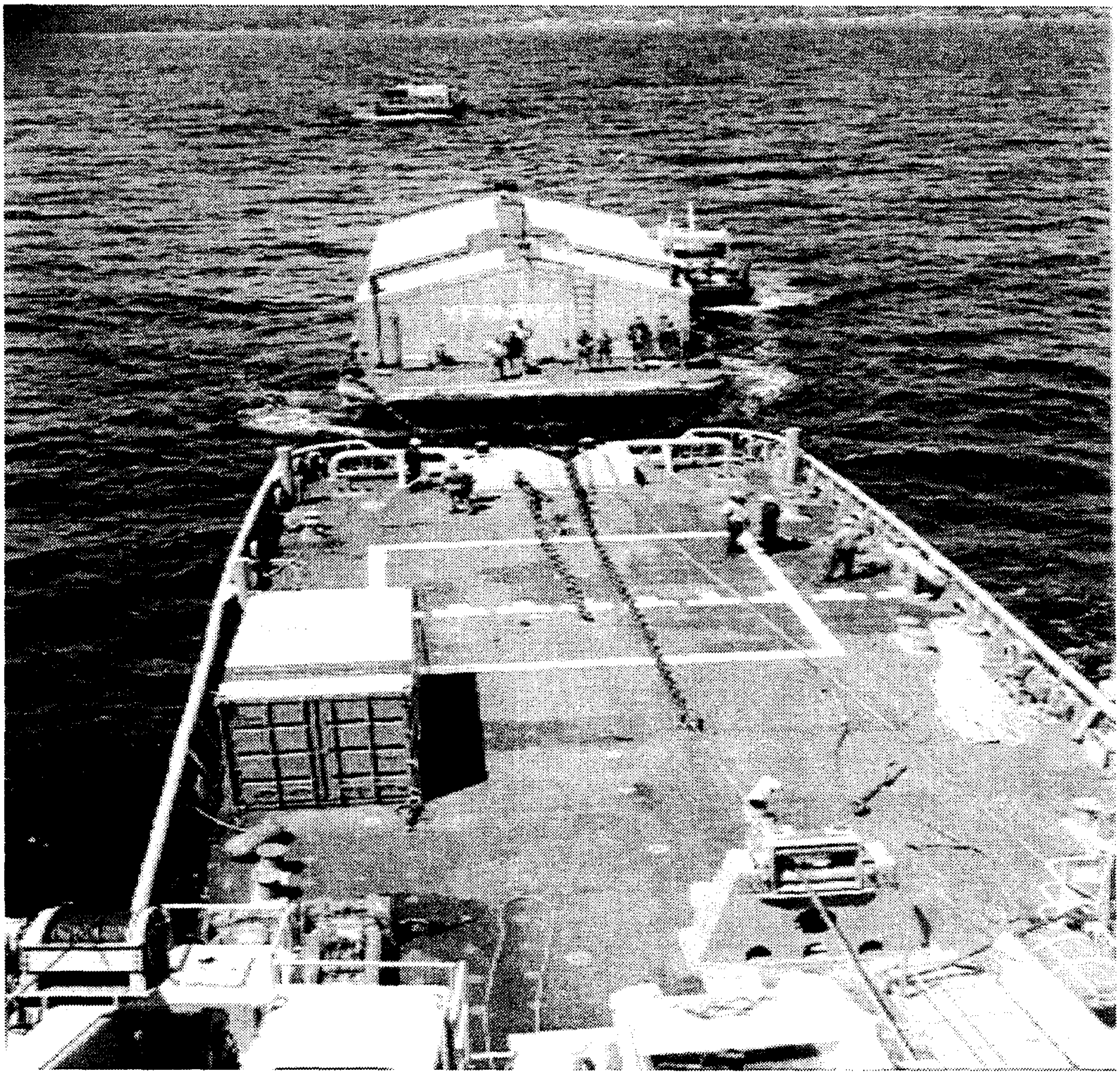

Figure 3-3. Two Barges in Tow Behind USNS MOHAWK Arriving off French Harbor, Roatan.

3-2.3.1.1 YC. Appendix R shows the plan and side views of the YC and the major specifications of the craft. Figure 3-4 shows the YC and YFN during the salvage.

3-2.3.1.2 YFN. The YFN is similar in configuration to the YC except the YFN has a 12-foot depth instead of 9 feet and an enclosure over the main deck Even though the depth of the YFN is three feet greater than that for the YC, the maximum rated load for the YFN is also 550 tons. The enclosure was modified by removing the aft quarter to provide room to load several large pieces of equipment which included a 20-ton Grove crane. Figure 3-5 shows the configuration of the YFN.

3-2.3.2. Structural Modifications

3-2.3.2.1 Padeyes. Both barges were modified for use in a heavy lift configuration by installing five padeyes on the centerline of the deck. Each padeye was centered over a tank compartment bulkhead to take

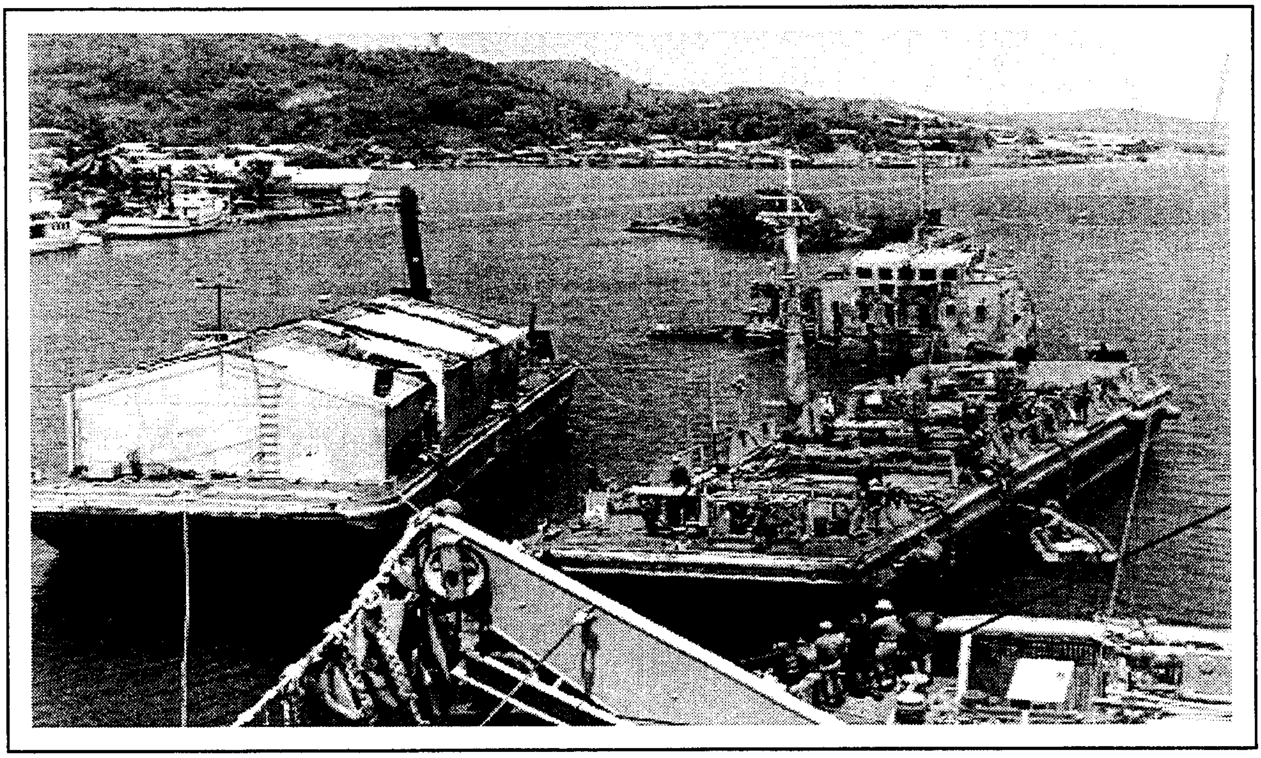

Figure 3-4. YC and YFN During Salvage.

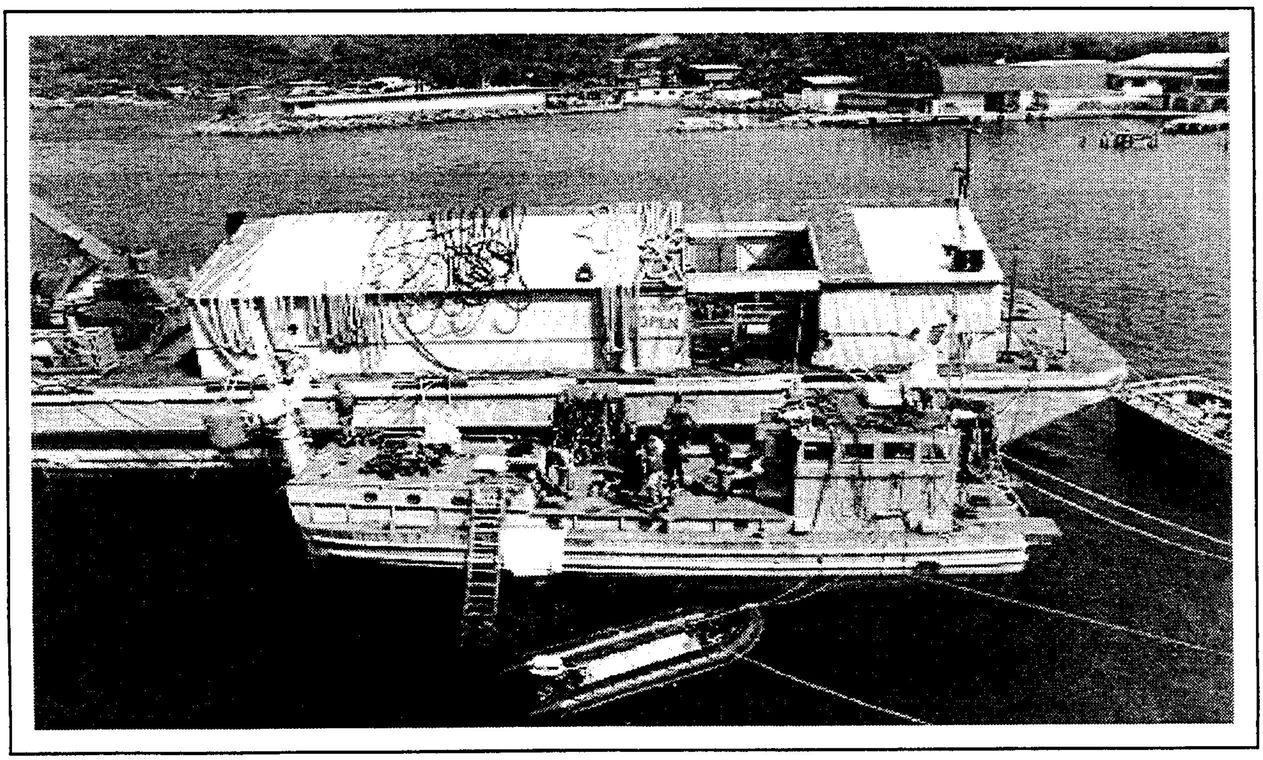

Figure 3-5. YFN Configuration.

advantage of the maximum strength of the barge structure. Figure 3-7 shows the location of the padeyes on the barges. Appendix A discusses the padeye design and installation.

Manufacture of the padeyes was accomplished with the assistance of NAVSEA 00C and Cheatham Annex ESSM personnel who supplied the steel plate material and cut the plate to the required dimensions. Welders from SIMA, Norfolk and COMSUPPRON EIGHT ships constructed and attached the padeyes to the barges. Figure 3-6 shows the installation of the padeyes by SUPPRON EIGHT personnel.

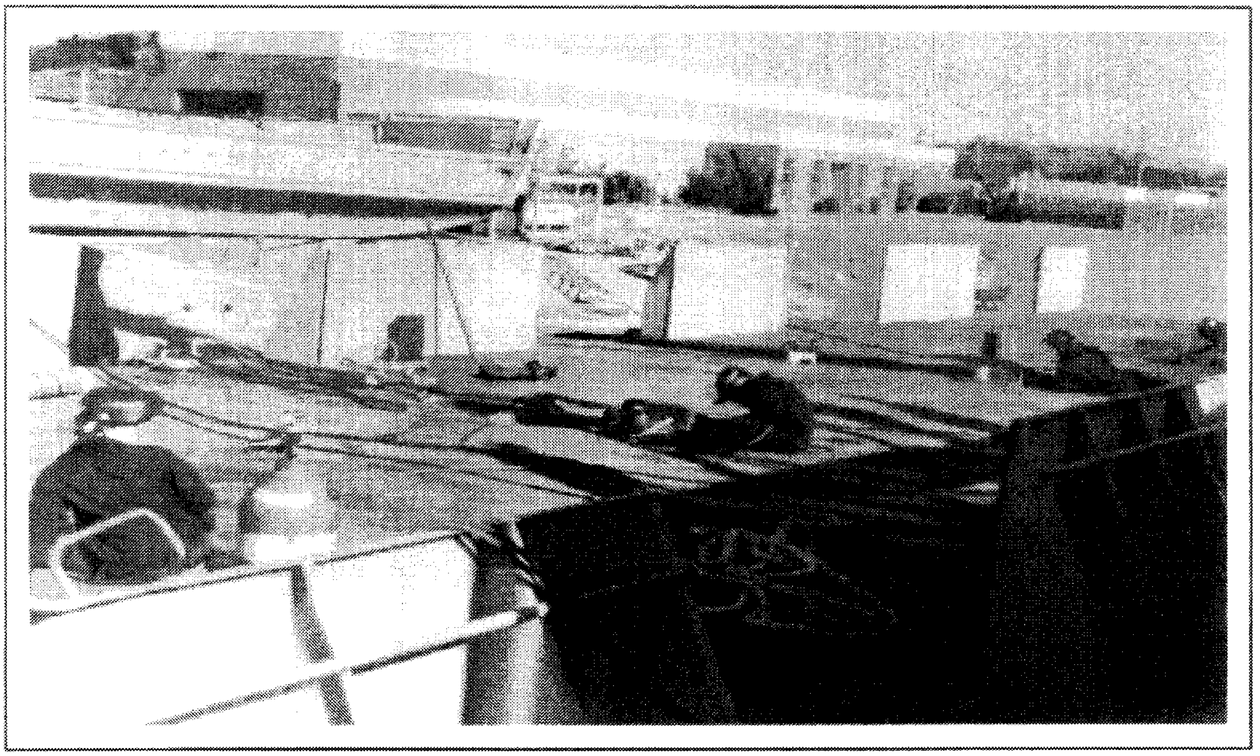

Figure 3-6. Installation of Padeyes by SUPPRON EIGHT Personnel.

3-2.3.2.2 Deck Edges. To handle the stress of the cables as they passed over the deck edges of the barges, 5-foot sections of 6-inch angle iron were welded in place. 10x14-inch oak docking blocks (Figure 3-8) were also obtained to provide an 8-inch minimum radius for the cable as it passed over the deck edge. This radius and the additional structural angle iron ensured that failure by cable slicing and shear would not occur. Appendix B discusses cable slicing as it pertains here and to WENDY.

3-3 PHASE II: RIG WENDY FOR HEAVY LIFT/REFLOATING

The initial salvage plan was to run lifting chains underneath WENDY and use the two barges to lift WENDY off the bottom. The two barges would be flooded down, the slack taken up on the lifting chains, and the barges de-watered to provide a maximum lift capability of approximately 1100 tons. WENDY would then be moved into shallower water until WENDY again grounded. This procedure would be repeated until WENDY's compartments were directly accessible for de-watering. As compartments were de-watered, the lift and pull sequence would be repeated until WENDY could be completely raised in a stable condition.

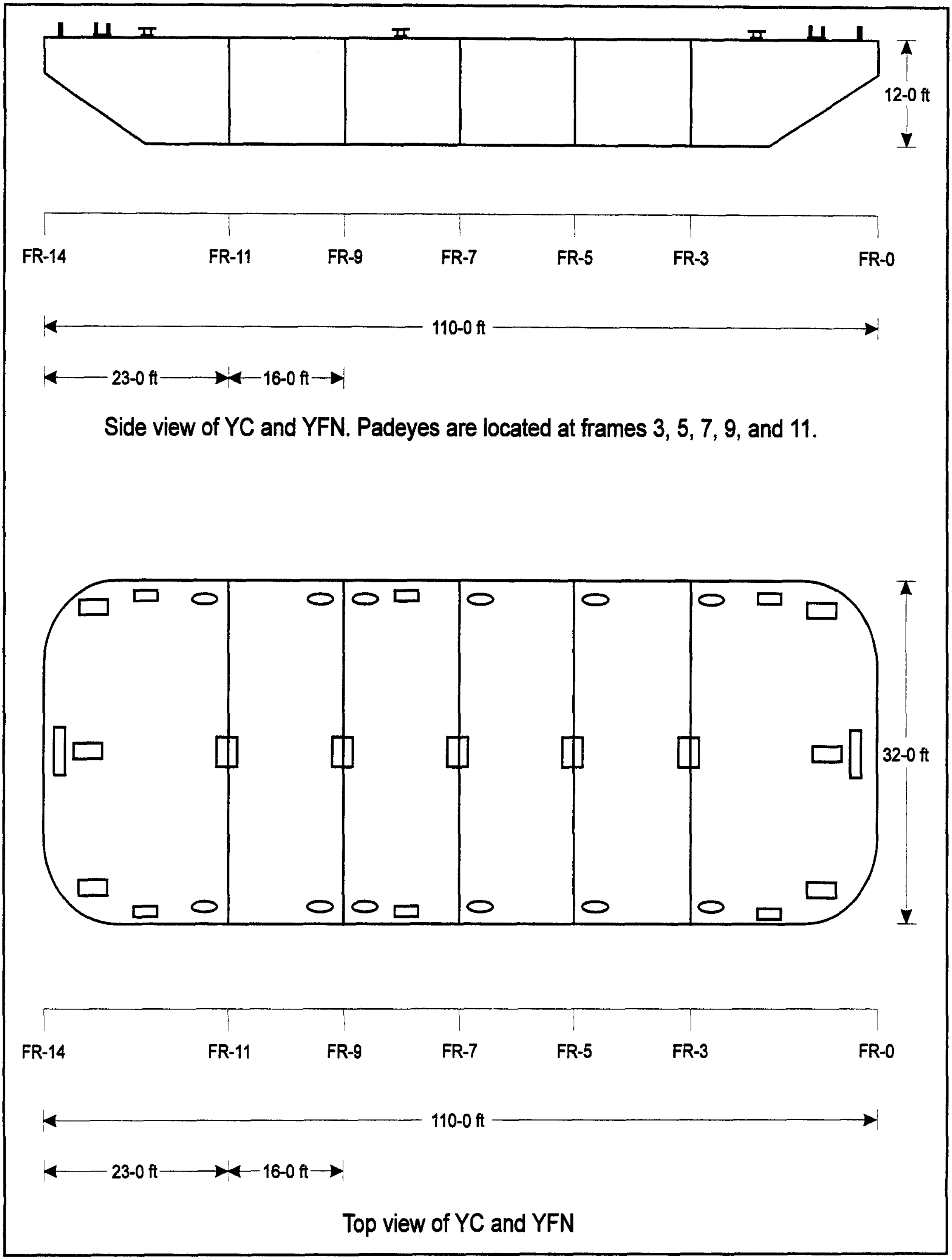

Figure 3-7. Location of Padeyes and Layout of YC and YFN.

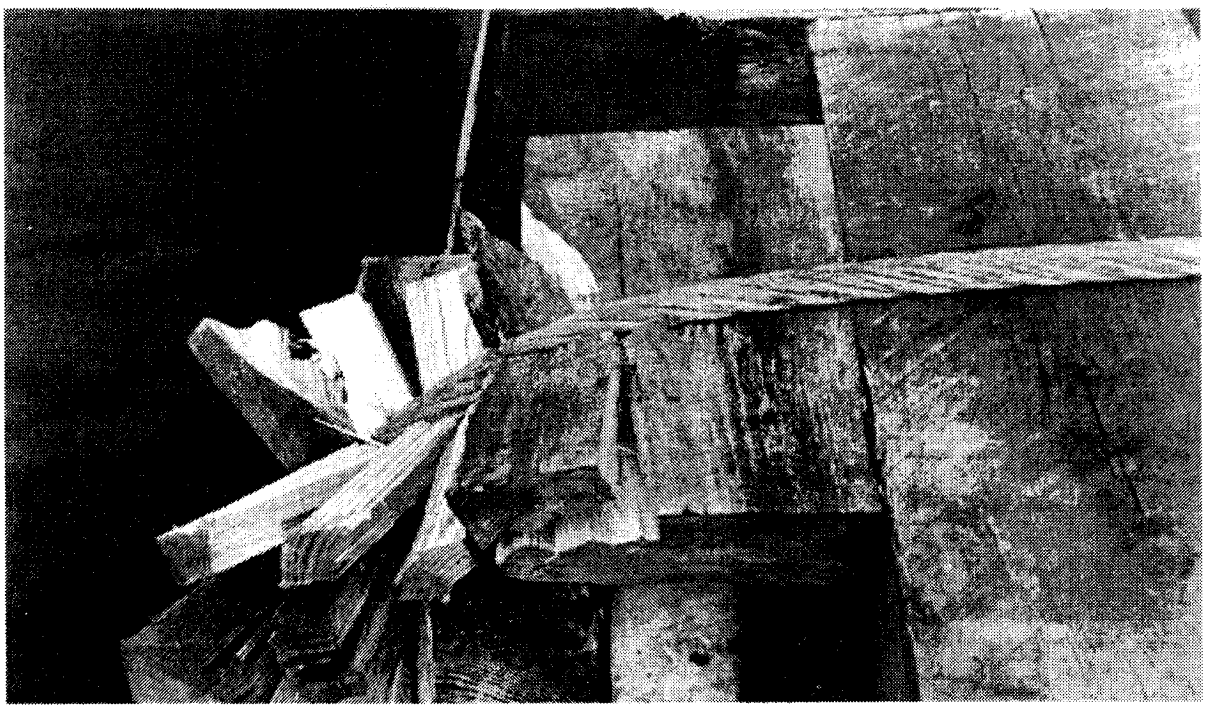

Figure 3-8. Barge Deck Edges Showing Structural Reinforcement.

3.3.1 Running Cables. The initial plan to install the lifting chains involved two phases. The first phase required divers to scour underneath the stern to allow them to place a 7/8 wire under the keel. This wire would then be pulled from the stern forward until it was positioned where the chain was to be run. For the second phase, the chain would be attached to one end of the wire and the wire would then be used to pull the chain around the ship.

Scouring and placing the wire under the stern went smoothly. However, problems were encountered during the attempts to pull the cable under WENDY. Several attempts to pull the wire under the hull from the stern were unsuccessful. Divers then went down and scoured out on the port and starboard sides where the wire dove under the ship. Divers found the wire hung on the starboard bilge keel and reported the port side clear. The pulling wire was passed to USNS MOKAWK and another attempt was made to pull the wire under WENDY. The pull was aborted when the strain gauge reached 65,000 pounds. Another set of divers then discovered that the wire was indeed hung up on the port bilge keel. Although the bottom was readily moved with water jets and air lift, the soft silt bottom slumped easily which inhibited tunneling under the ship unless vast amounts of bottom were removed.

During these attempts, another team of divers made progress in patching and installing pumps in the various compartments, and verified the structural integrity of these compartments. There was no indication that de-watering these compartments would provide any difficulty at all.

3-3.2. Re-Floating Plan. Based upon the progress made in preparing the forward compartments for de-watering, the structural integrity and the probable success in de-watering the spaces, the salvage plan was modified. The salvage plan now shifted to one which would require the compartments forward and a significant portion of the compartments aft be de-watered to provide sufficient buoyancy to raise WENDY off the bottom. The barges were to be used to control the vessel as she came to the surface and provide stability once she broke the surface. The critical aspect of this plan was controlling WENDY as she came to the surface. Several elaborate scenarios were proposed but none could be considered reliable. Failing to develop a workable plan to use the barges to control WENDY on her way to the surface, the decision was made to pull WENDY to shallower water after pumping compartments to reduce her ground reaction.

3-3.3 Superstructure. During the initial planning stages to float WENDY, it was apparent that any water caught in the superstructure would result in a large weight at a large KG. Initial plans involved cutting the superstructure completely off. This plan was discounted because of the large cofferdam that would have to be manufactured to seal the engine room stack access. As an alternate plan, large holes were to be cut in all superstructure compartments to allow the rapid drainage of all water. Cutting of these holes started and progressed past the point at which the decision was made to abandon the float plan because of the benefit of de-watering the superstructure rapidly during the pulling evolution discussed in section 3-4.

To further reduce KG, any accessible weight topside was removed. This included anchors, the ship's chain, three mil vans and the booms.

3-4 PHASE III: PULL TO SHALLOWER WATER

By moving WENDY to shallower water, the following major factors would be accomplished.

1. Reduce the water pressure acting on the hull and as a result, the stress produced on any de-watered compartment bulkhead structure. This was a concern due to the lack of zinc's on the hull and WENDY's depth of 60 feet of sea water. The actual condition of the hull was unknown. WENDY had been sunk since 1990 and the preservation of most commercial ships which are usually run hard is always of concern.

2. Reduce the depth at which divers would be required to work for any remaining underwater work. Maximizing the diver's work time while minimizing the chances for decompression problems is always a priority. In WENDY's case, the 60-foot bottom depth limited no decompression dives to 60 minutes.

3. Reduce the head pressure, and therefore flow rate, on any leaks into compartments being de-watered. Even with multiple de-watering pumps installed, de-watering of the bosun locker and the engine room was difficult, and in the case of the bosun locker, ultimately impossible.

4. Maintain ground reaction and therefore stability during the final stages of salvage. The free surface problems posed by the engine room, aft dunnage hold and the cargo hold were significant and had to be accounted for to ensure the ship would not roll over. POSSE indicated that there were severe problems with stability anytime we attempted to bring WENDY to the surface directly from her initial position. Analysis indicated that by bringing WENDY's stern clear of the water, there would be sufficient ground reaction to support the stern of WENDY as we re-floated the bow section and exposed the main cargo hold.

3-4.1 Compartment De-Watering. The first action was to seal the bosun locker and forward upper peak tank/chain locker. These spaces were expected to be the easiest to seal and were the only compartments forward. By partially pumping these compartments, in conjunction with the steering and aft dunnage hold, the ground reaction would have been reduced sufficiently to allow WENDY to be dragged into shallower water. From here, direct access to the engine room from the superstructure could be achieved and the engine room could be de-watered without concern for the structural integrity of the stack.

When the forward compartments could not be pumped out, divers turned their attention to the aft compartments. Based upon the POSSE model (Appendix I), de-watering the aft dunnage hold, steering compartment and a small fraction of the engine room would then allow WENDY to be dragged up the beach to the point where the after compartments would be accessible for final de-watering. However, the initial POSSE model used a lightship displacement of 400 tons. As a result of this error in determining the proper lightship displacement, a significant amount of water had to be pumped from the engine room in order to move WENDY into shallow water.

3-4.1.1 Forward Compartments. Patches were installed on all holes that could be identified by the divers. An access was cut into the forecastle deck over the bosun locker. A patch was then manufactured and installed with fittings for a six-inch hydraulic pump. The pump was then installed into the upper peak tank through deck openings in the bosun locker. Figure 3-9 illustrates the positioning of the pump within the compartments. This configuration would ensure that both the bosun locker and upper peak tank would be de-watered completely. A pnuemo hose was attached to the deck in the upper peak tank to monitor the de-watering progress.

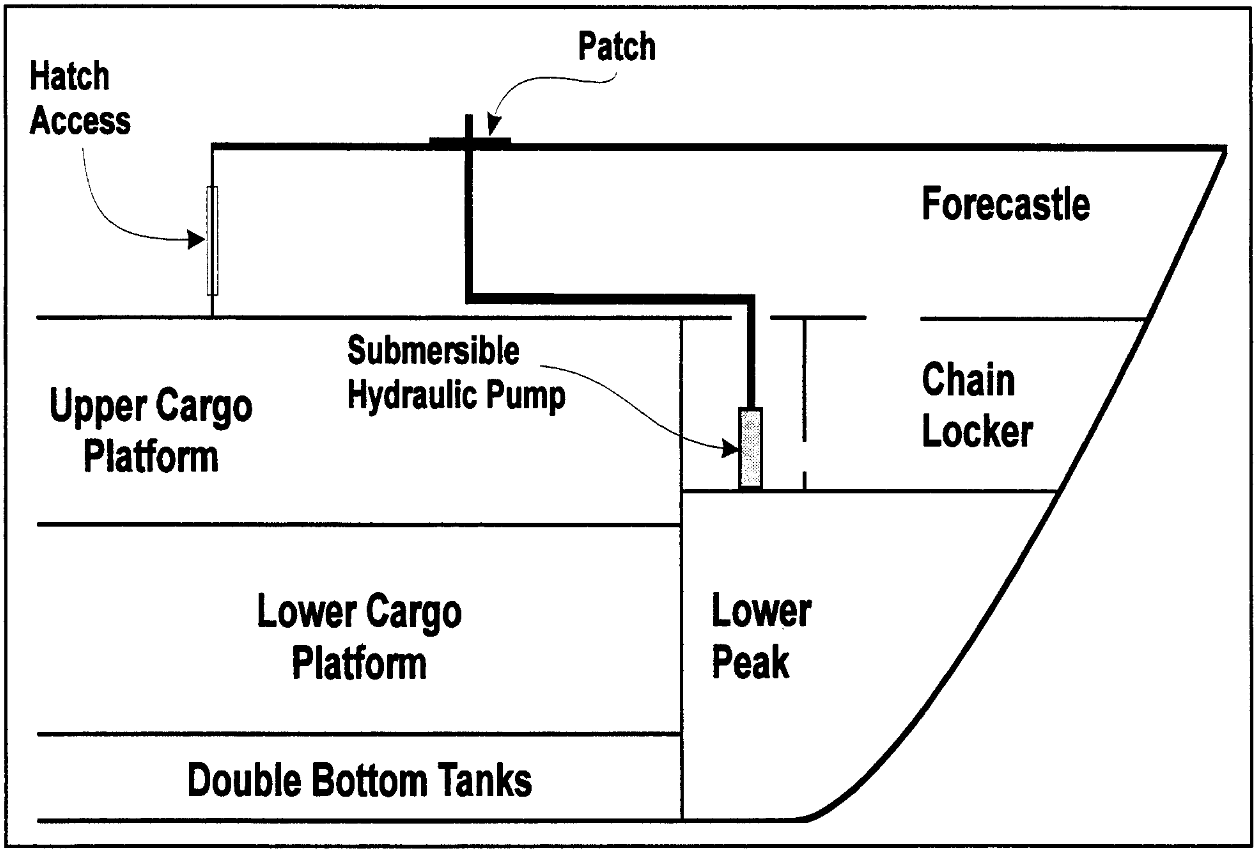

Figure 3-9. Placement of Submersible Hydraulic Pump in Forward Compartments. The Lower Peak was not Accessible to Divers.

Test de-watering attempts failed repeatedly with no significant water removal indicated by the pnuemo. Over a several day period, attempts to locate the leaks by use of dye injection, diver inspection in adjacent compartments and outside the ship had limited success in identifying the source(s) of water.

A final attempt was made to de-water these compartments by adding a compressed air source at the top of the bosun locker. When pumping was resumed, air was blown into the compartment to assist de-watering by placing a pressurized air pocket inside and thus blowing the water out. Due to the pressure required to overcome the ambient water pressure, only a few feet could be attained before air escaped from the dogged water tight door.

The decision was made not to delay any further attempts at de-watering the forward compartments until WENDY was pulled into shallower water. Re-examining the salvage plan using POSSE indicated that if the aft dunnage hold and the steering compartment could be fully de-watered there would still be sufficient buoyancy to allow WENDY to be pulled.

3-4.1.2 Aft Compartments. Divers surveying the dunnage and steering compartments identified numerous vents and piping terminations that required patches and plugs. At the same time, divers completed the initial survey of the engine room and were attempting to seal all the leaks identified. Divers installed strongbacks on the doors leading into the space and identified as many valves as could be found and ensured that they were shut.

The top of the stack was roughly two feet below the surface and therefore required a cofferdam to be constructed and installed to provide water tight access directly to the surface. It was through this access (Figures 3-10 and 3-11) that the de-watering pumps were installed. Numerous attempts at de-watering the engine room space with a six-inch and two three-inch diesel pumps succeeded in achieving only a couple of feet. Significant de-watering occurred only after an additional 4-inch hydraulic and a 4-inch electric pump were installed. As the engine room was de-watered, additional leaks were identified by salvors looking down the stack. Once the location of the leaks were determined, divers were able to locate them and install various damage control plugs to secure them. Using all four pumps, the test de-watering of the engine room was successful.

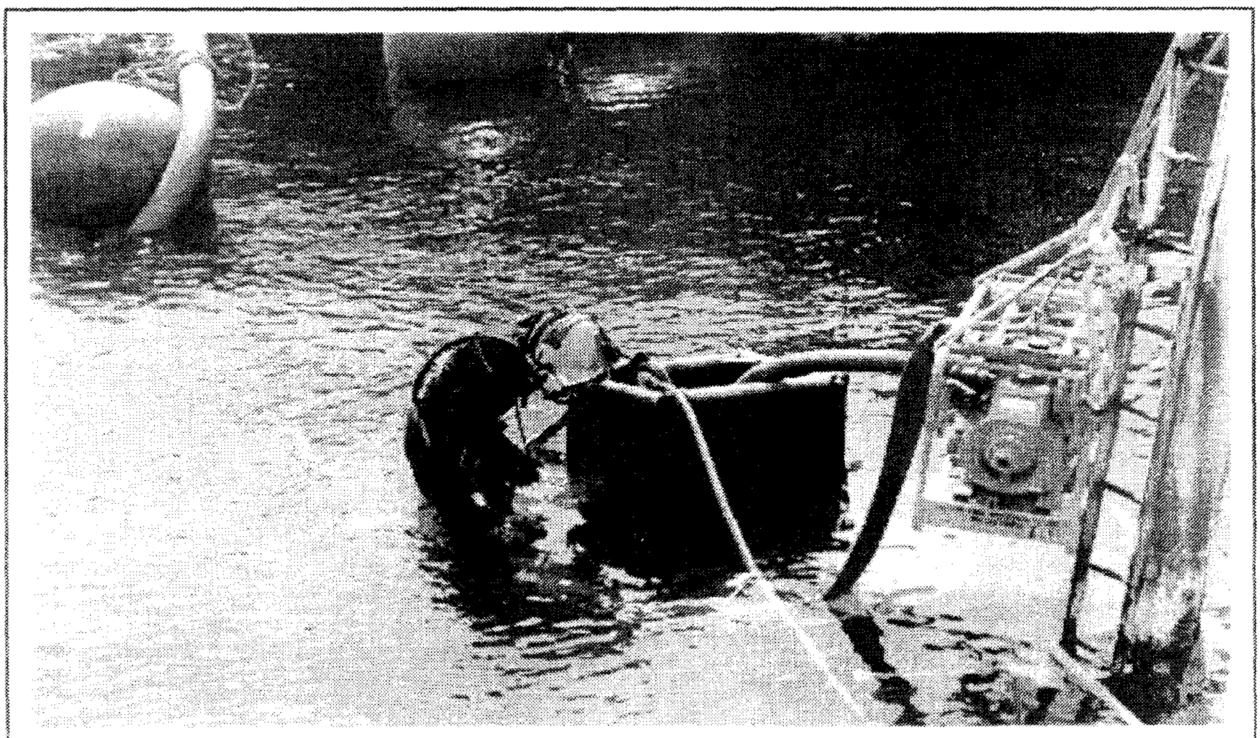

Figure 3-10. View of Cofferdam Attached to the WENDY Stack.

3-4.1.2.1 Dunnage Patch. The most challenging patch was the dunnage access which measured 18 feet by 4 feet. A 5/8-inch HY-80 plate patch was designed (Appendix D) and manufactured with fittings for a single six-inch hydraulic pump. The resulting patch, shown in Figures 3-12 and 3-13, was estimated to weigh over 1,800 lbs. and was installed over the access and secured. Shoring was installed underneath the patch to prevent buckling of the patch due to the 23-foot head of water overhead. Test pumping of the two compartments indicated rapid de-watering and a good seal.

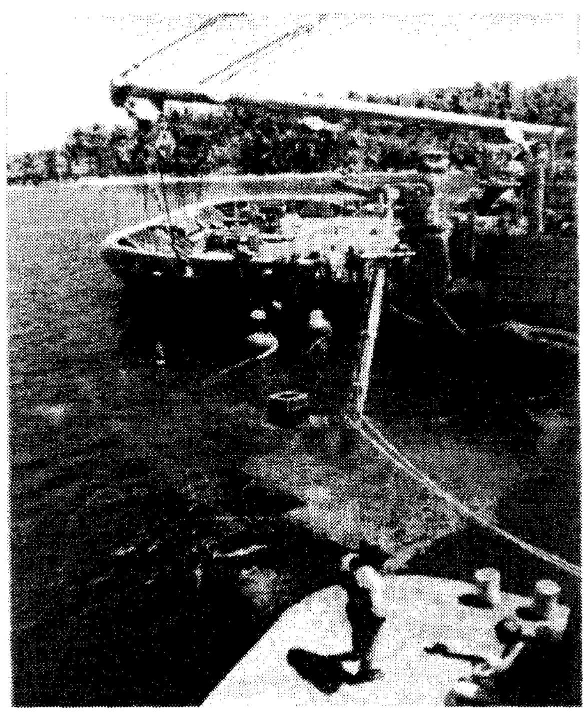

Figure 3-11. USS GRASP and YFN Working Alongside WENDY.

3-4.1.2.2 Engine Room Stack. During the engine room de-watering, there was considerable concern over the ability of the stack plating to withstand the hydrostatic loading once the internal water level was reduced below the main deck. Calculations (Appendix E) indicated that failure of the engine room stack would occur if de-watering of the engine room was undertaken. Therefore, de-watering of the engine room was considered a last resort if de-watering of all other compartments failed to achieve a sufficient reduction in the ground reaction. As the plating did not fail as was predicted, it can only be assumed that the frame spacing and/or material was heavier than reported by the divers.

3-4.2 Beach Gear. To develop the required force necessary to pull WENDY into shallower water, three stato anchors and three hydraulic pullers were used. Each stato anchor was rigged to a shot of 2 1/4 chain

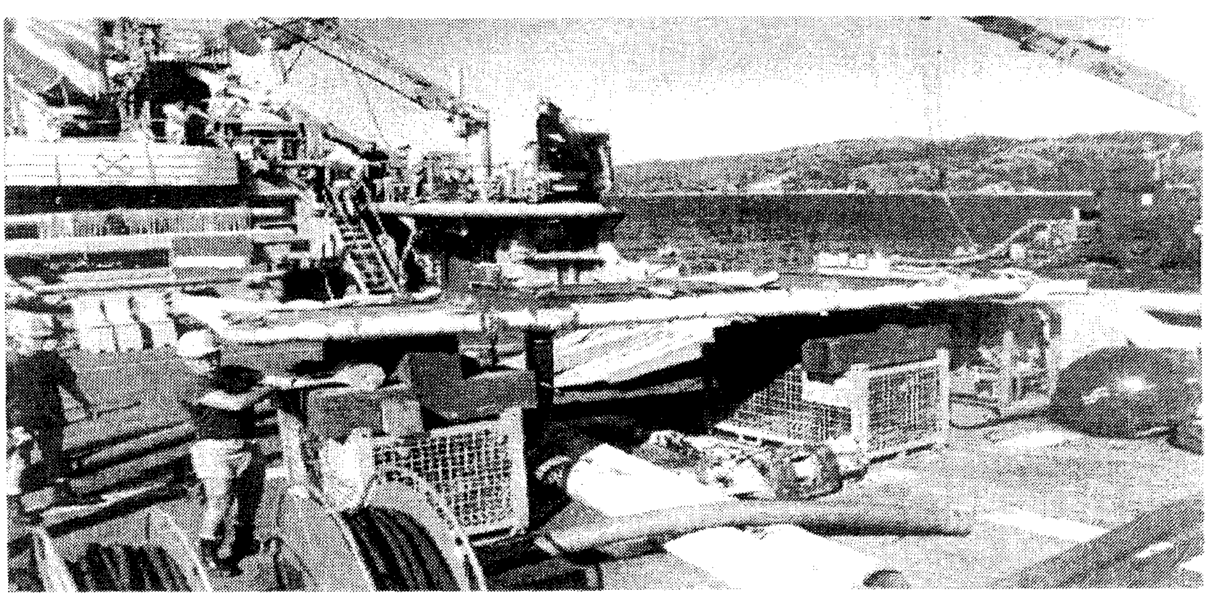

Figure 3-12. Aft Dunnage Patch Before Installation.

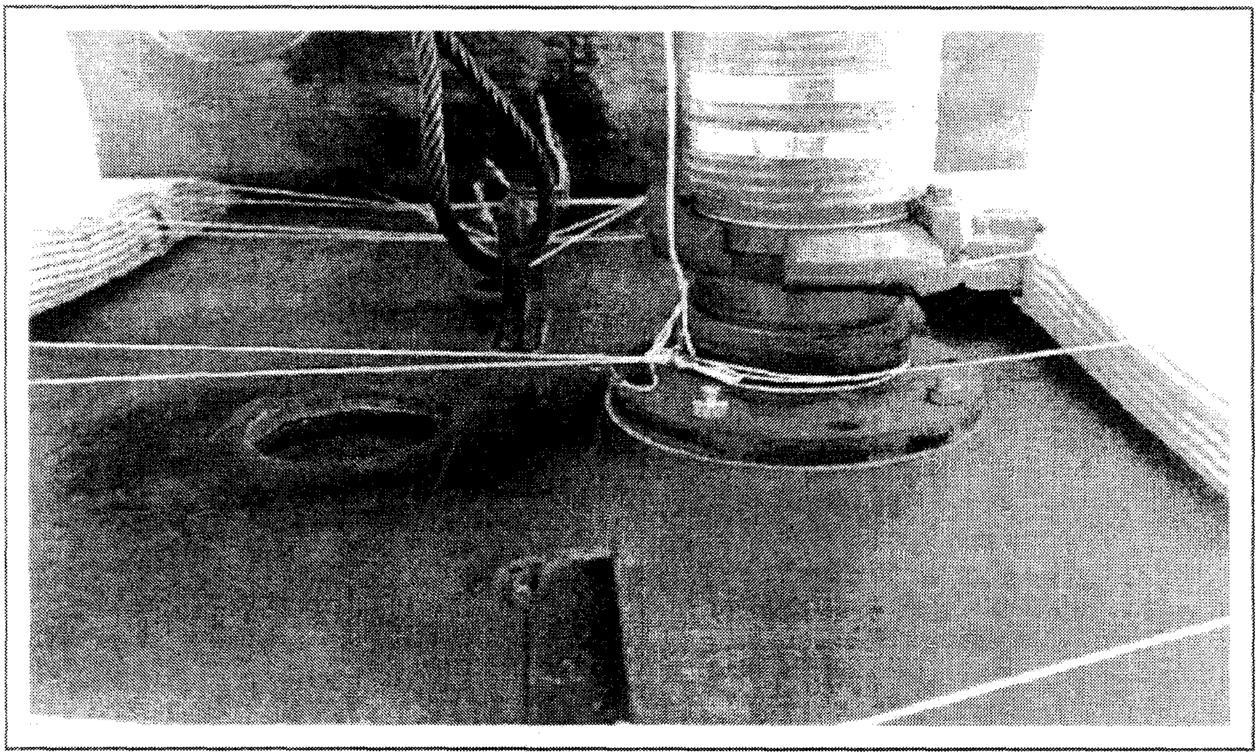

Figure 3-13. Aft Dunnage Patch Showing Pump Discharge Fitting.

chain and then to a 1 5/8 wire. The wire was then taken directly to the hydraulic puller located on the YC as shown in Figure 3-14.

The slope of the bottom which cradled WENDY, the location of Osgood Key and the spit island determined the location of anchor placement. Figure 3-15 shows the location of the anchors with respect to WENDY and the surrounding geography. To lay the anchors, the YC was rigged with the three anchors hanging over the side (Figure 3-16). The YC was used due to their weight and the shallow water (9 feet maximum) in the channel through which the vessel carrying the anchors had to pass in order to drop the anchors. The YC was maneuvered into position by using the two work boats from USS GRASP and a kedge anchor line going to a portable capstan mounted on the YC (Figure 3-17). Throughout the salvage, the portable capstans proved to be invaluable. They are highly recommended for use on future operations. Setting of the anchors was accomplished using the hydraulic pullers on the YC after the YC had been configured as a pulling platform.

3-4.3 Pulling Barge Configuration.

3-4.3.1 Initial Pull YC Configuration. In preparation for the initial pull, the YC was configured as shown in Figure 3-18 and the YFN was not utilized. The three hydraulic pullers were mounted on blocks over the strength padeyes and secured to 2 1/4-inch chain which was run around the girth of the barge. This would prevent the pullers from being pulled off of the barge should either end of the purchase part.

WENDY was made fast to each puller with 2 1/4-inch chain. The chain was attached to WENDY's stern by wrapping it around the stern and then securing it to either the port or starboard double bollards or to the

Figure 3-14. YC Configuration Showing Hydraulic Pullers and Beach Gear.

centerline capstan. Figure 3-19 shows this configuration after the initial pull of WENDY. The chain was prevented from slipping from underneath the hull by the skeg structure just aft of the rudder post.

3-4-3.2. Second Pull YC Configuration. For the second pull, only positions 1 and 2 were used to pull directly on WENDY as shown in Figure 3-20. The third stato anchor was reconnected to a sheeve through which GRASP's tow wire would pass. The Port 2-1/4-inch chain on the stern of WENDY was fastened to GRASP's tow wire would pass. The port 2-1/4-inch chain on the stern of WENDY was fastened to GRASP's 2-1/4-inch wire which passed through the sheave as shown in Figure 3-21. The YFN was configured for heavy lift as shown in Figure 3-22 to provide a reduction in forward ground reaction.

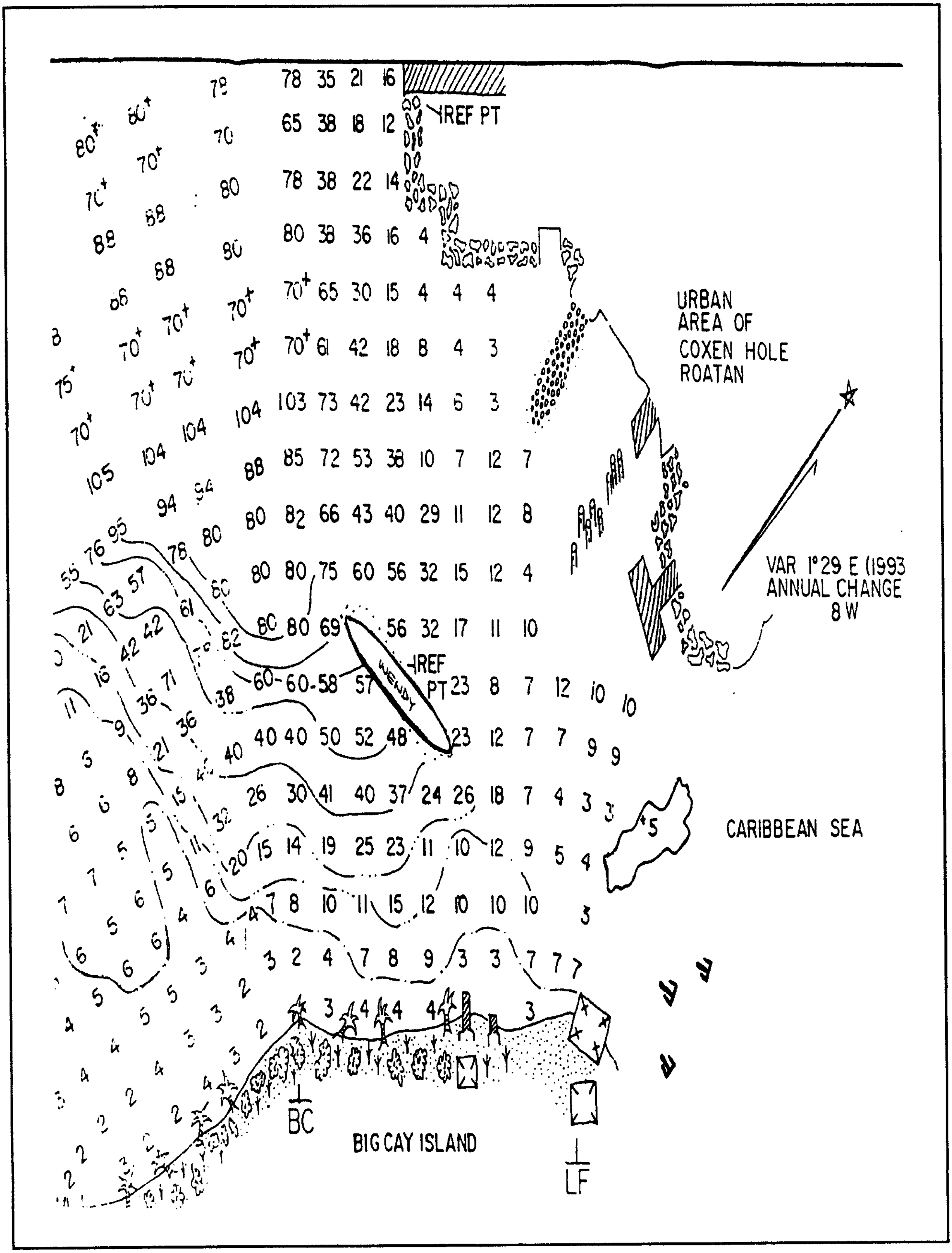

Figure 3-15. Location of the Anchors with Respect to the WENDY and the Surrounding Geography.

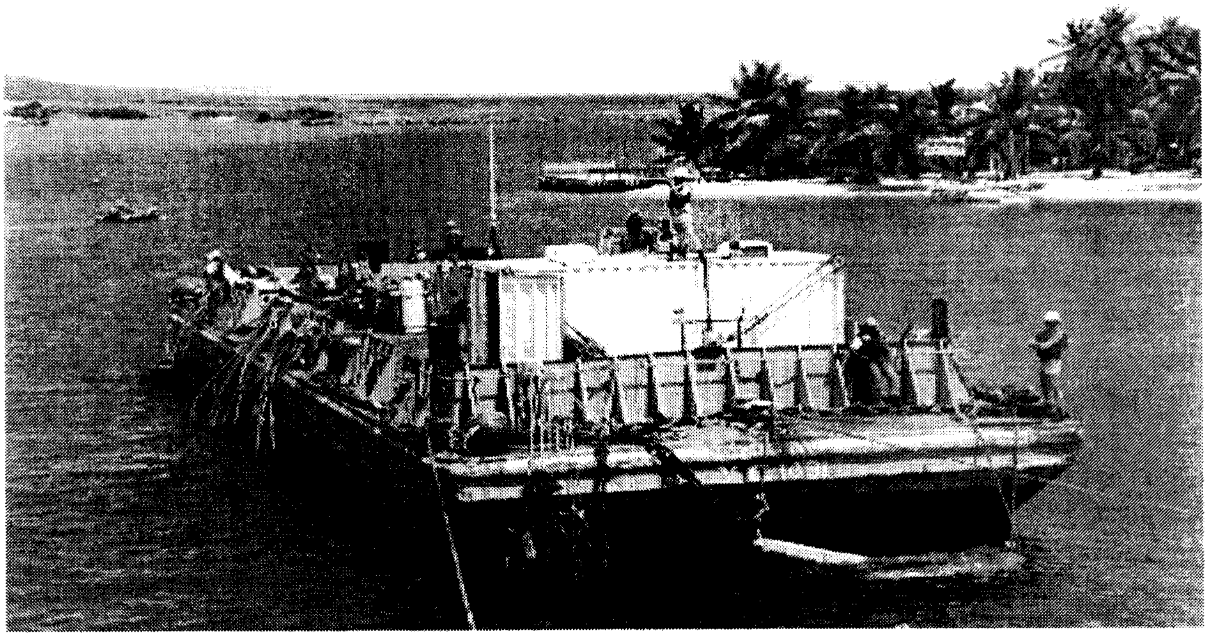

Figure 3-16. YC Rigged with Anchors for Placement in Shallow Water.

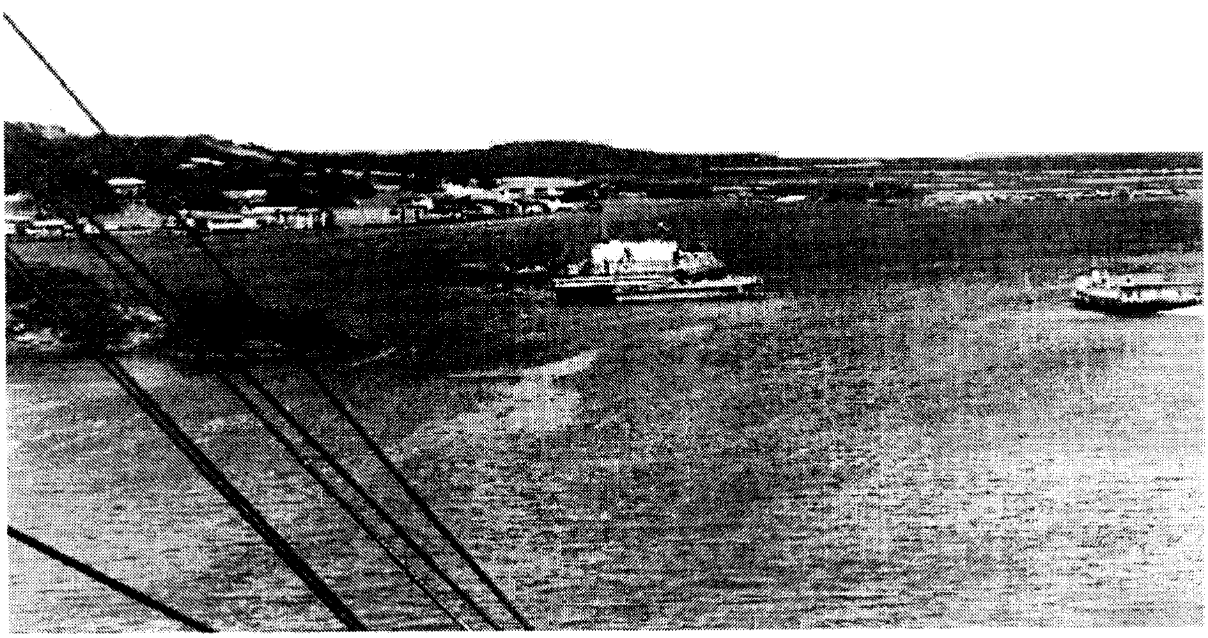

Figure 3-17. YC with Anchors Being Manuvered into Position to Drop a Beach Gear Anchor.

Figure 3-18. YC Configured for Pulling WENDY with Three Hydraulic Pullers.

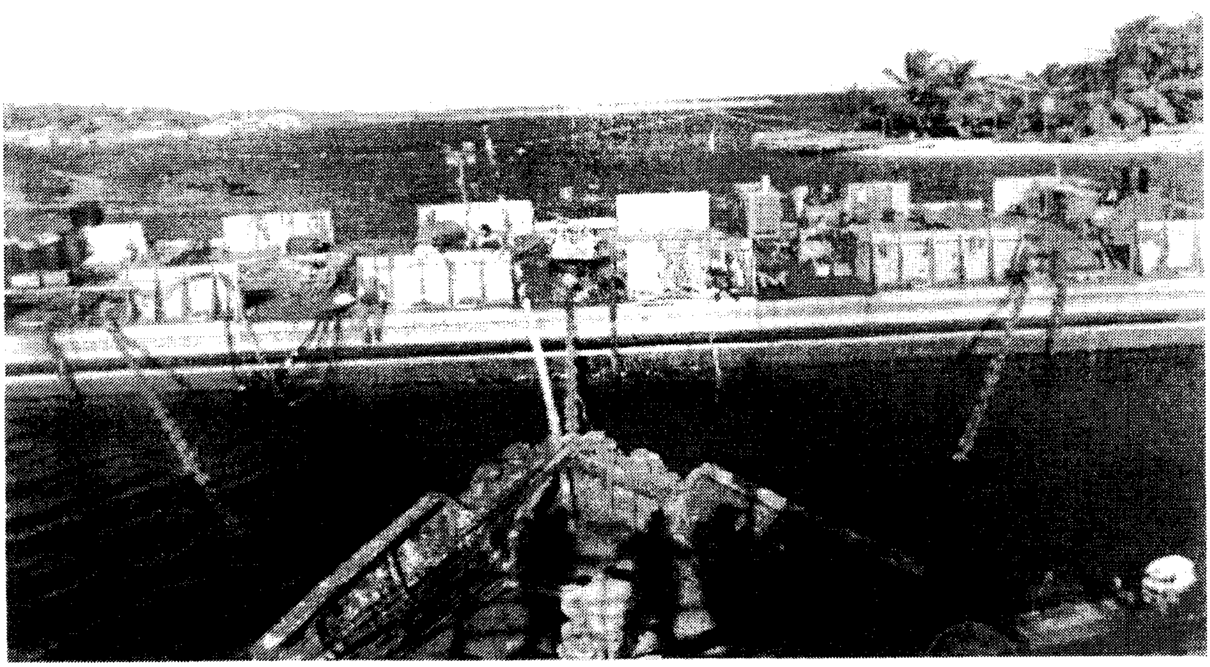

Figure 3-19. WENDY Stern Rigged for Pulling with 2 1/4 inch Chain.

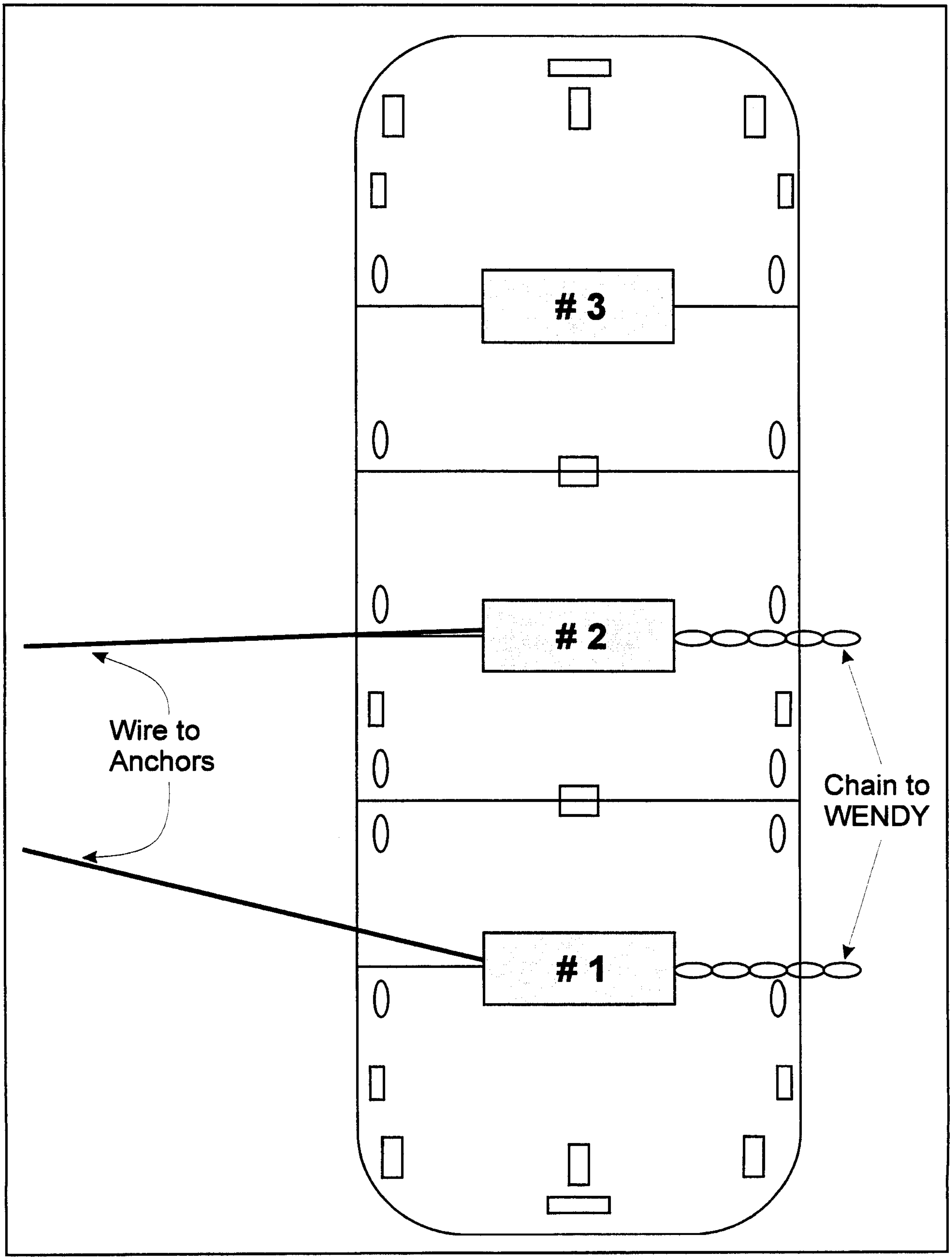

Figure 3-20. YC Puller Configuration for Second Pull of WENDY. Hydraulic Puller #3 is Idle.

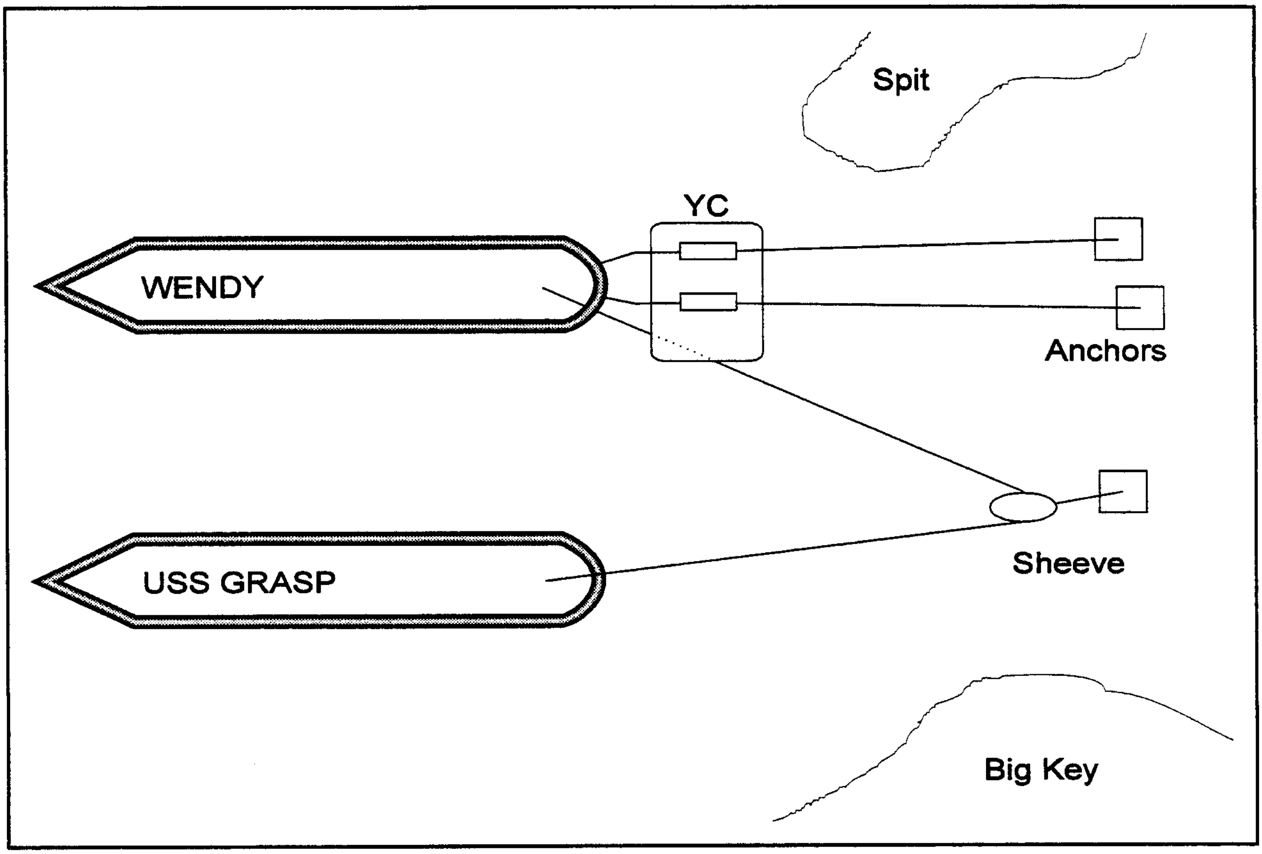

Figure 3-21. USS GRASP and YC Pull Configuration for Second Pull of WENDY into Shallow Water.

With the test de-watering of the aft compartments completed and the pulling barge rigged to the beach gear and WENDY, the pull to shallower water could begin. The initial attempts to drag WENDY up the slope to shallower water all failed to achieve any noticeable movement. It was not until the engine room was de-watered approximately 70 percent in addition to the dunnage and steering compartments that WENDY started to move. This had been confirmed earlier that day after the POSSE model had been updated with the 800-ton lightship displacement and was predicting that the engine room would have to be de-watered approximately 80 percent in order to move WENDY. As a result of the error in lightship weight, the excess buoyancy provided by the engine room for which the remainder of the salvage plan had depended, was lost. Figures 3-23 thru 3-30 show the sequence of pumping and dragging WENDY into shallow water.

The stern of the WENDY was now clearly exposed allowing access to the remaining compartments aft. Overall, the WENDY had been dragged approximately 180 to 200 feet and the bow was now resting in approximately 48 feet of water.

3-4.3.3 YC Ballasting. To achieve additional lift and further reduce the required freeing force, the YC was used as a lift barge at the same time it was being used as a pulling barge. The YC tanks were fully flooded using 3-inch de-watering pumps and fire hoses. The ballast obtained was about 140 tons for each tank. The slack in the 2 1/4-inch chain from WENDY to the hydraulic pullers was then taken in. After the maximum strain (50,000 lbs. each) was taken on the hydraulic pullers, the two tanks were de-watered. This added lift and the resultant additional freeing force combined to initiate the retraction of WENDY. Appendix F presents an in-depth analysis of this configuration.

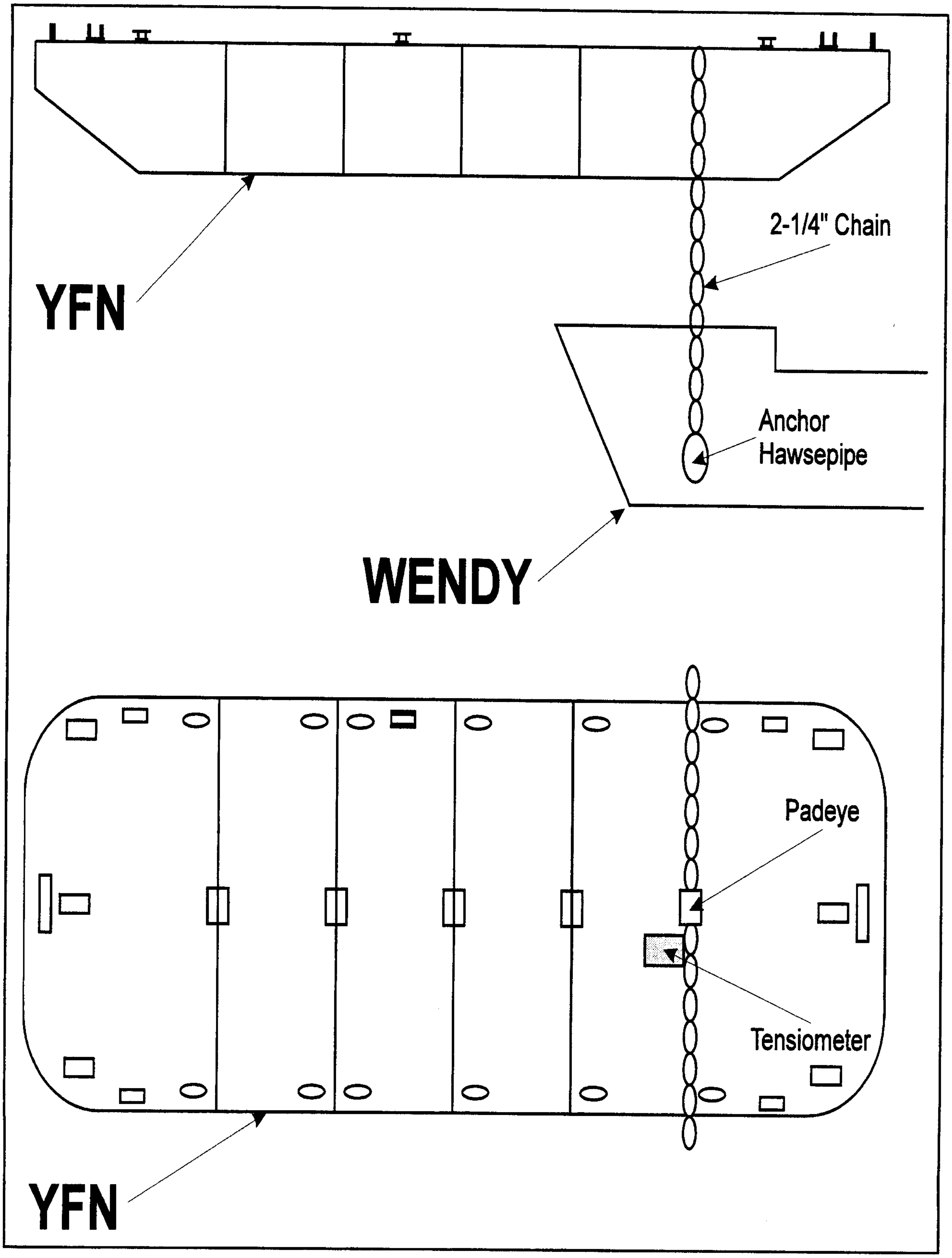

Figure 3-22. YFN Configuration for Heavy Bow Lift of WENDY for Second Pull into Shallow Water.

3-4.4.2 Ballasting. POSSE showed that by filling tank five completely and tank six to 70 percent, the main deck of the YFN would come awash and a maximum lift of 240 tons would be generated. An additional 70 tons of buoyancy or 4 feet of lift height could then be achieved by counter flooding tank number one. Fire hoses were set up to flood the tanks and a six-inch diesel pump was rigged for de-watering the tanks and counter flooding.

During the de-watering evolution, the first 70 tons of water removed from tank five was used in taking up slack in the two chains attached to WENDY. This left roughly 170 tons of lift which was applied to WENDY's bow. This value was later re-estimated at 120 Ltons due to the rise of WENDY's bow and the resultant loss of lift from the barge.

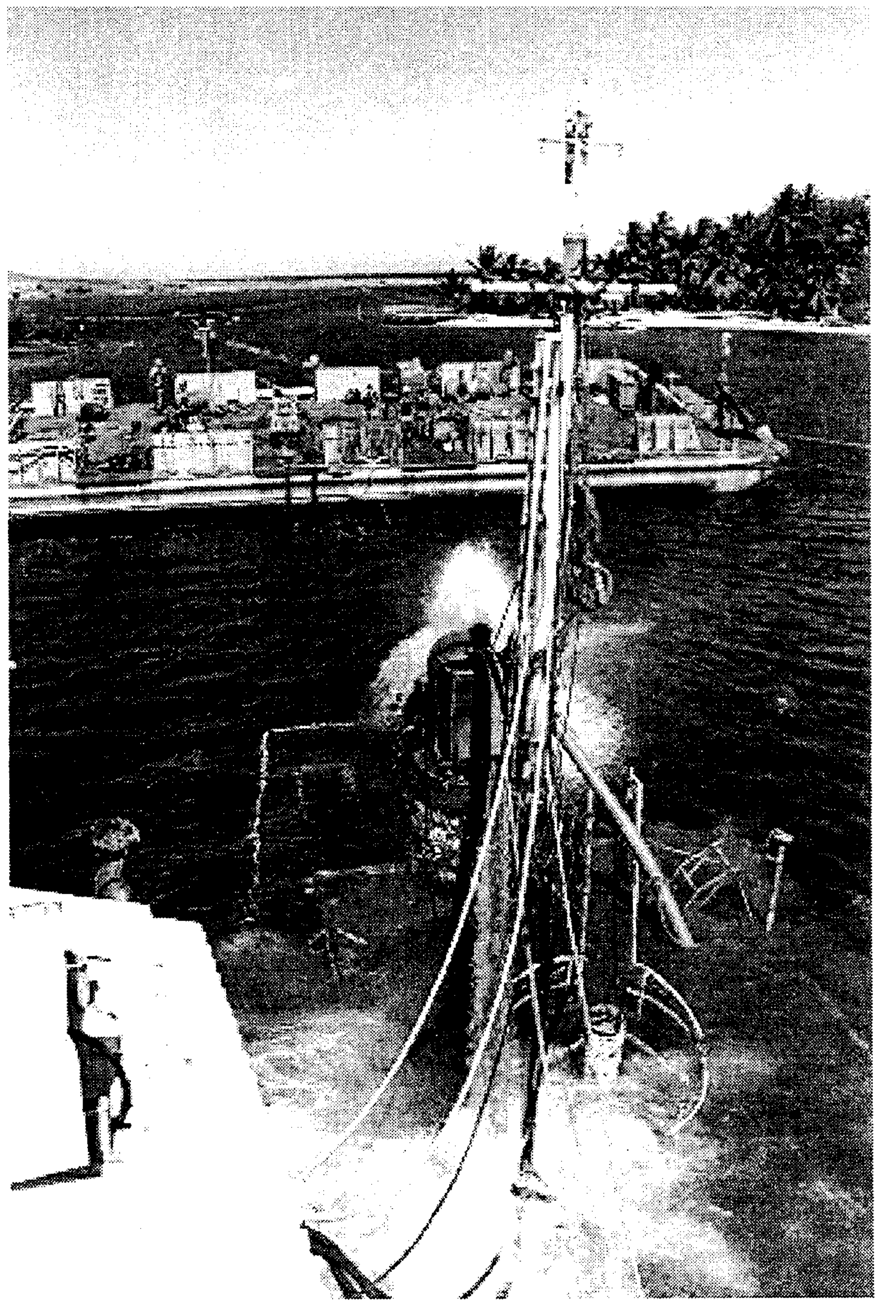

Figure 3-24. WENDY, Stack Starting to Clear the Water.

3-4.4.3 Stability. Appendix P shows the stability curves for the YFN in the worst case condition of tanks five and six partially flooded as determined by POSSE. As can be seen, there was sufficient GM remaining in the YFN to assure that she would not become unstable.

If one of the chains parted, the worst case scenario resulted in a list of 23 degrees. Although the dynamics of the sudden release would have shaken equipment around, the YFN would still remain upright.

3-4.4.4 Structural Strength. The overall structural strength of the YFN was estimated to be within limits to handle the loading. However, buckling of the vertical hull plating directly under the lifting chain was noted after tanks five and six were de-watered and tank number one was being counter flooded. The tensi-

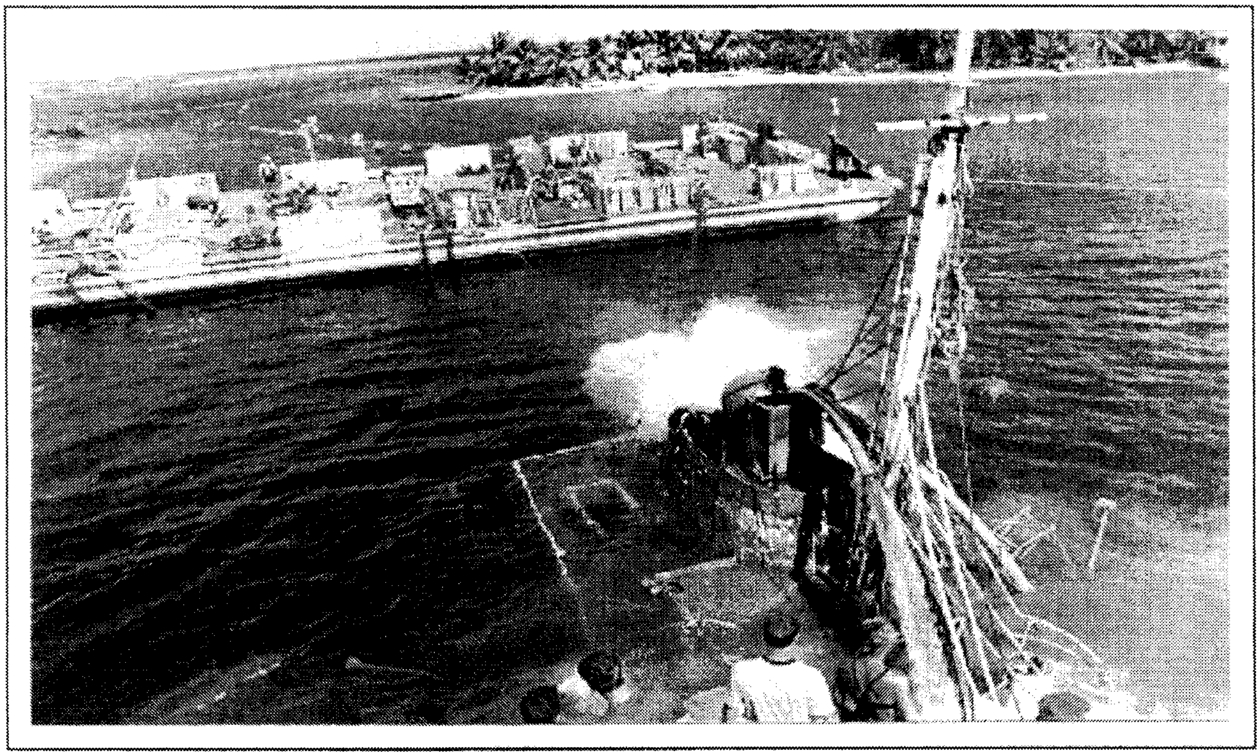

Figure 3-25. Pumping and Dragging WENDY Into Shallow Water.

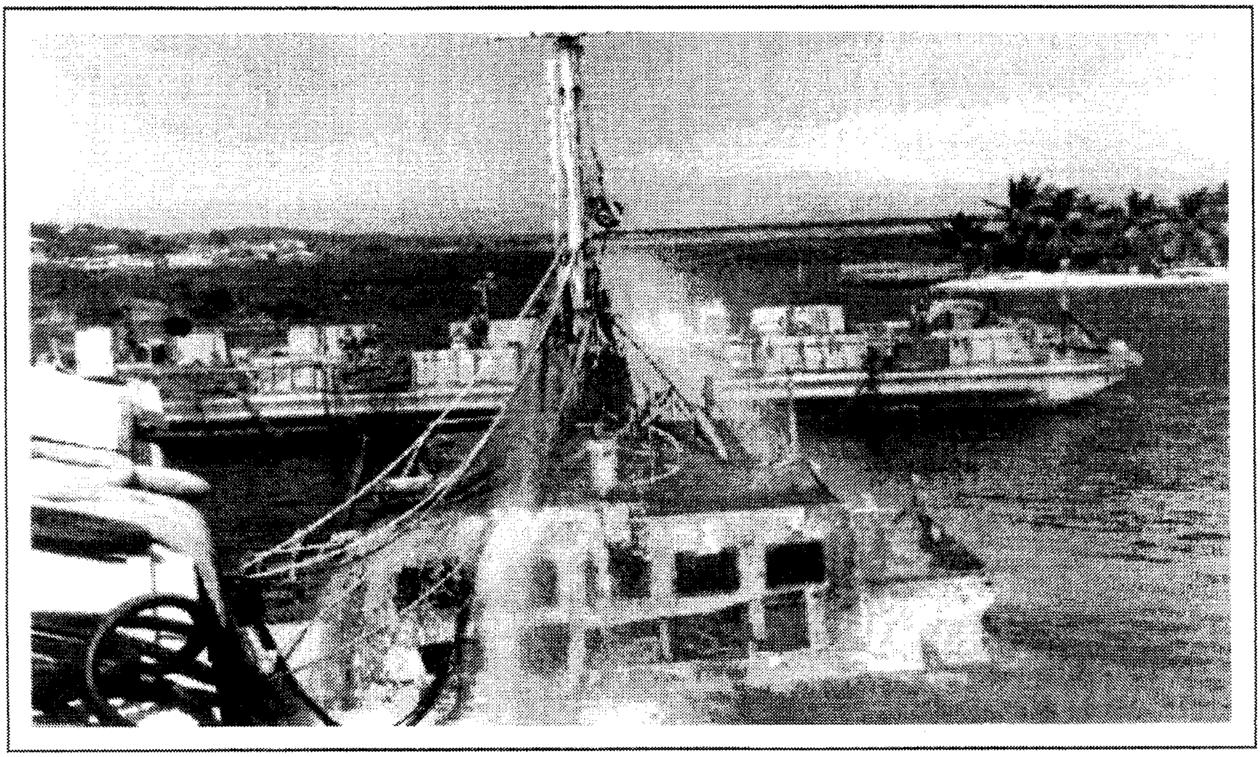

Figure 3-26. Pumping and Dragging WENDY Into Shallow Water.

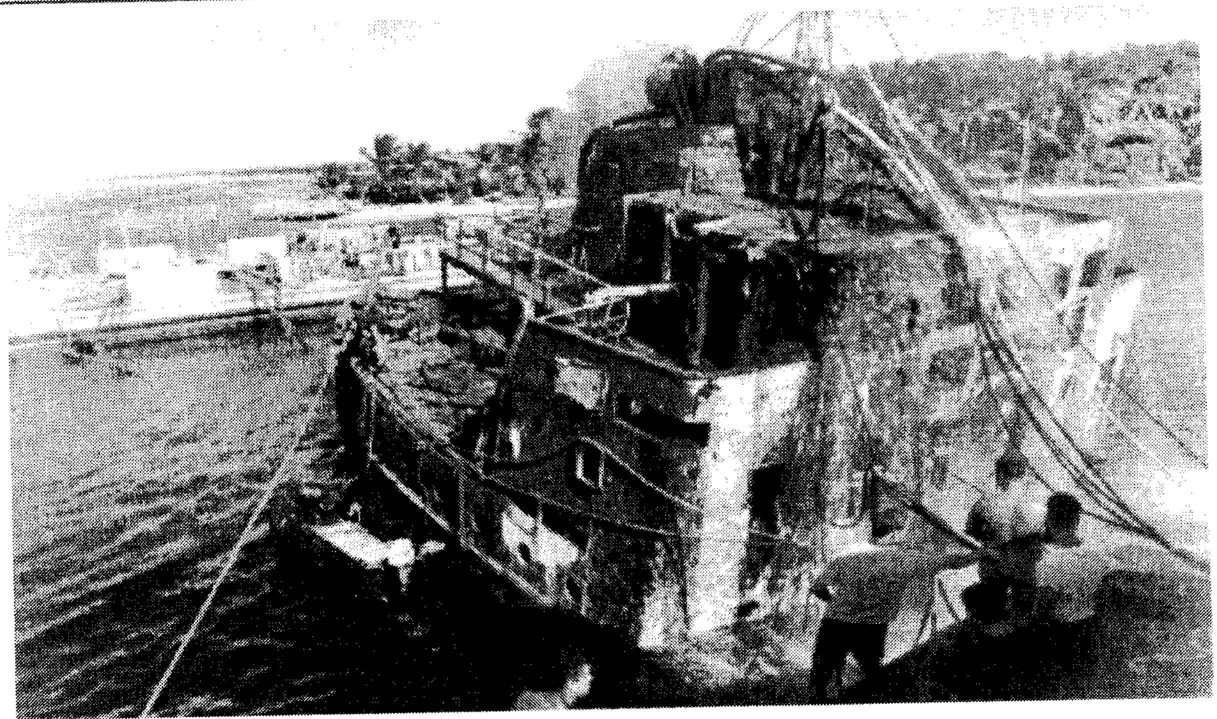

Figure 3-27. Pumping and Dragging WENDY Into Shallow Water.

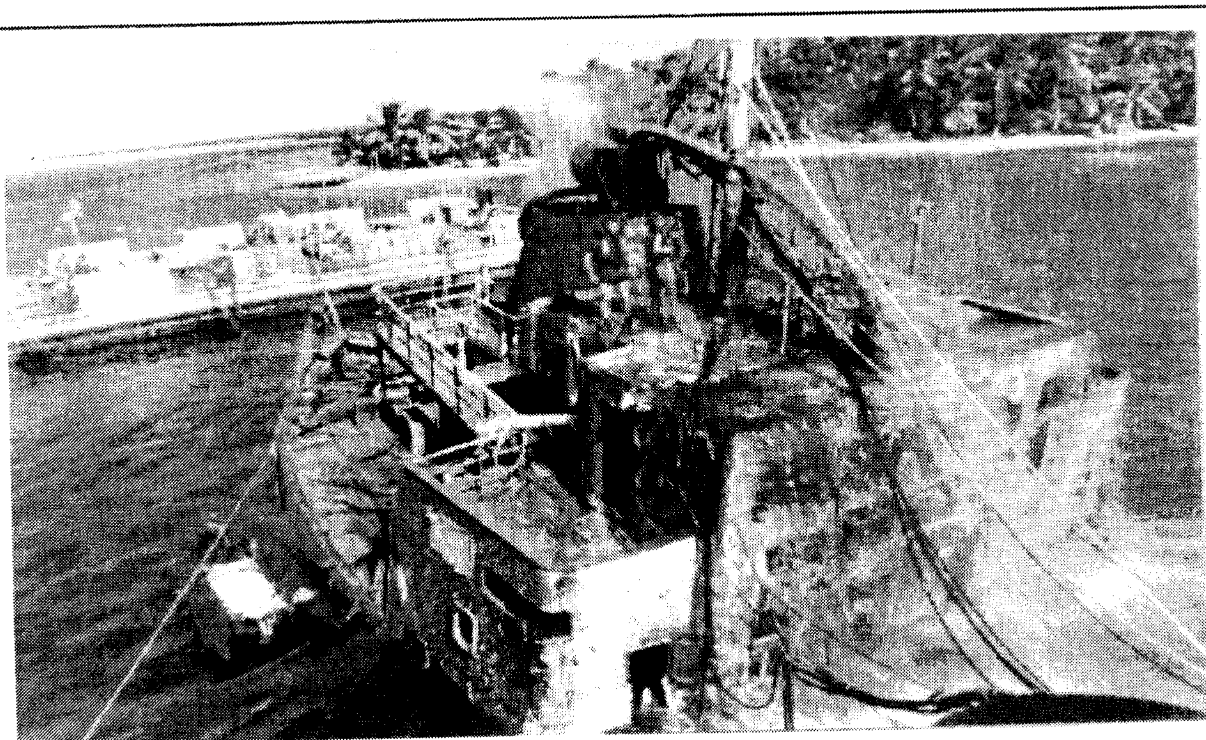

Figure 3-28. Pumping and Dragging WENDY Into Shallow Water.

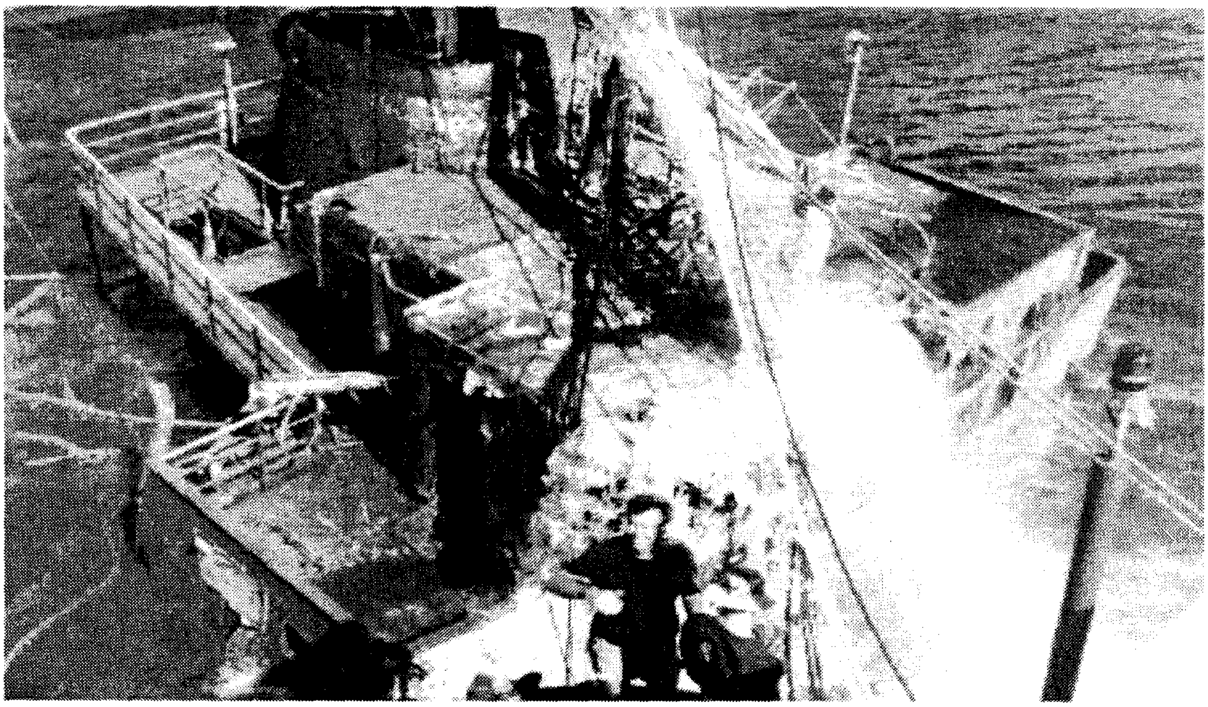

Figure 3-29. Pumping and Dragging WENDY Into Shallow Water.

ometer reading was holding steady at a reading equating to 92 tons of lift. Due to the chain leading over the edge of the deck, the tensiometer was not reading the total tension seen in the chain and thus the exact loading applied to the YFN bulkheads was not accurately known. The buckling was noted after approximately 50-70 tons of water had been flooded into tank number one. Flooding was secured and the number one tank was de-watered until approximately 30 tons remained. This was the condition of the YFN used during the second pull on WENDY. Inspection of the structure revealed minor buckling of structural stiffeners and plating and one cracked weld. Based on draft readings, an estimated load of 170-200 tons was developed at the time buckling was identified.

3-4.5 WENDY Configuration. In preparation for the second pull, the engine room of WENDY was completely de-watered and a damage control team plugged and secured all sources of incoming water. At the same time, all remaining compartments aft of the engine room and any tank that could be identified were opened and drained. As a result, an estimated 50 tons of additional weight reduction aft was achieved. De-watering of all the aft spaces could now be attained with several three-inch diesel pumps and the 4-inch electric submersible pump located in the engine room. Appendix J shows WENDY's configuration as estimated by POSSE.

3-4.6 USS GRASP Bollard Pull Configuration. The GRASP was rigged to pull WENDY with one of her auxiliary 2 1/4-inch wires through a sheave rigged through one of the stato anchors as shown in Figure 3-21. The 90 tons of hydraulic pull with GRASP's 70-plus tons of pull combined with the buoyancy from the YFN lift and the de-watered stern of WENDY were expected to move WENDY well up the beach. The pull was initiated with the hydraulic pullers on the barge. When the maximum pull was attained, GRASP commenced her pull and WENDY began moving. WENDY was moved 20-30 feet farther up the beach when GRASP's wire parted and no additional progress could be attained. Figure 3-31 shows GRASP at work.

3-5 PHASE IV: HEAVY LIFT OF WENDY BOW

At that point, it was determined that attempting to pull WENDY up the beach any further would not be easily accomplished. Also, whatever gain was achieved would not have a significant effect on the salvage of WENDY. A new plan of attack was now required to complete the salvage.

Just prior to the second pull of WENDY, divers noted WENDY's bow was raised three feet off the bottom due to the 170 ton lift from the YFN. As a result of this information (Appendix K), a salvage plan was proposed to configure the barges to dynamically lift the bow with 240 tons of lift. Once the forecastle was brought to the surface, salvors would then de-water the forward compartments. The main cargo hold access would then be above the waterline and pumping of the cargo hold could then begin.

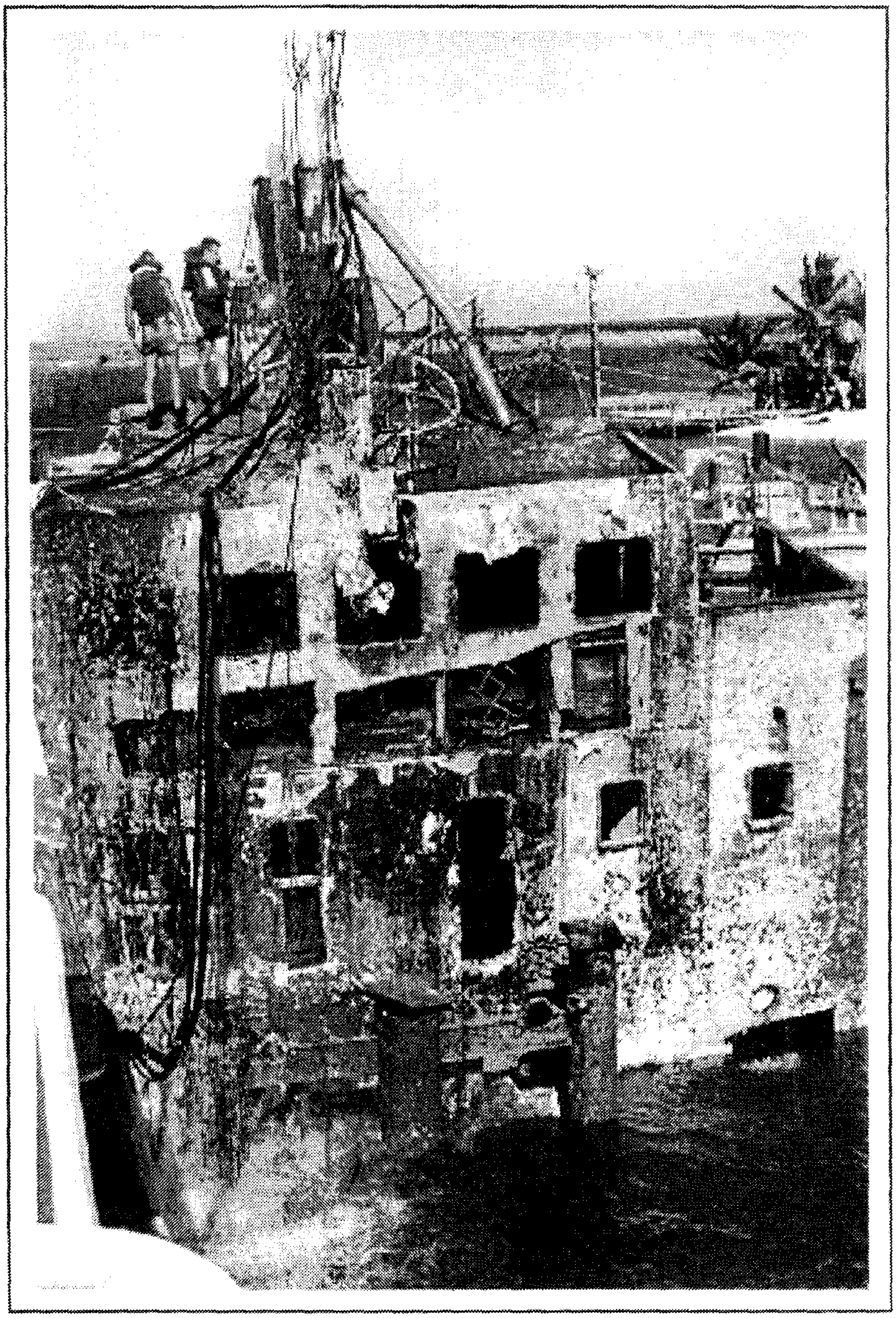

Figure 3-30. WENDY After Completion of Initial Pull.

3-5.1 Lifting Barges. The requirement now was to configure the two barges to perform a dynamic heavy lift of WENDY's bow. The depth of water at the bow was 48 feet and the water depth at the forecastle deck was 18 feet. A static lift could not bring the deck awash to allow a damage control team to combat the flooding directly and a heavy lift crane or derrick was not available.

The main concerns were the strength of the barge hull where the outboard wire turned under the barge and the stress that would be developed and carried by the single outboard wire.

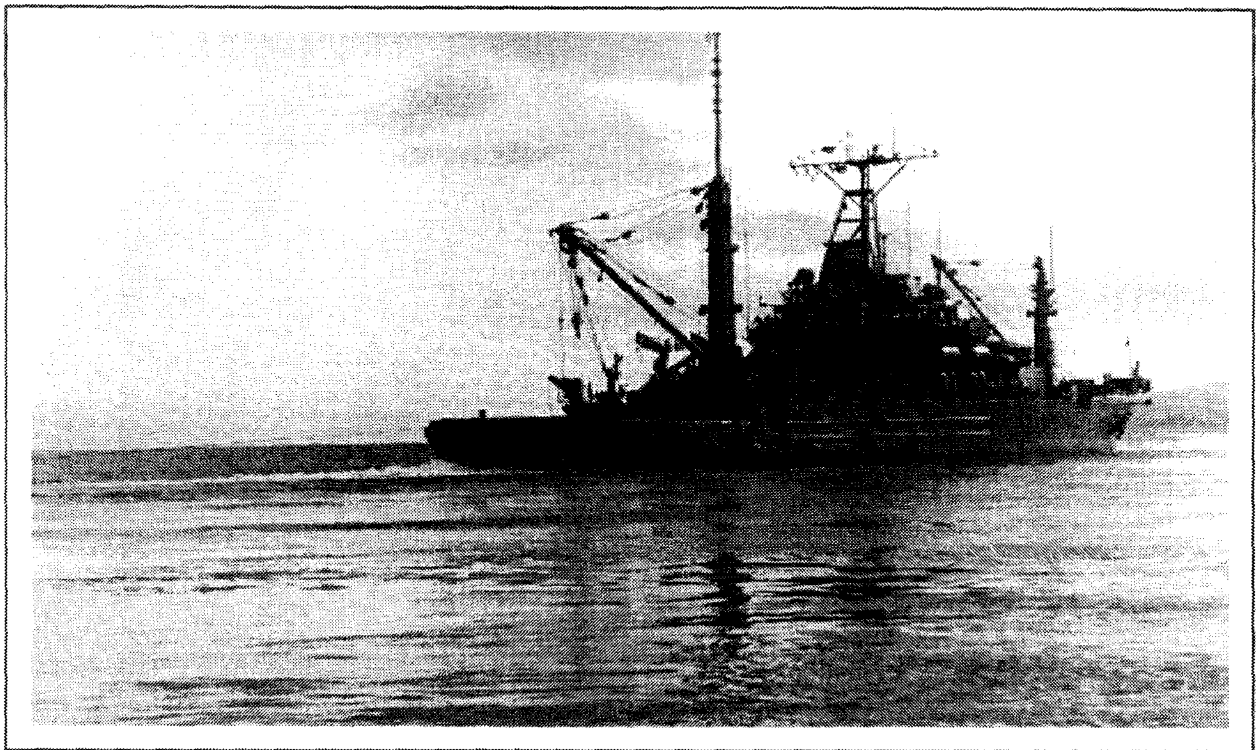

Figure 3-31. USS GRASP Pulling on WENDY During the Second Pull.

3-5.1.1. Barge Configuration. Five hydraulic pullers were used to provide the dynamic lift. Figure 3-32 shows the configuration of the pullers and barges. The four pullers pulling the inboard wires would provide the main lifting effort. The single outboard puller would provide minimal lift but would mainly provide stability for the barges and minimize the list.

The barges were to be positioned as far forward as possible to maximize the lever arm and take advantage of the chain hawsers on WENDY's bow. The forward-most wire would pass through the hawser and the remaining lift wires would be run under the hull.

To minimize friction and wire slicing of the barge edges, steel plates with a 16-inch radius were welded to the deck edges. Grease was then applied before and during the lifting attempts.

3-5.1.2. Ballasting. To minimize the initial list and take up slack and pre-load the lifting wires, the two barges were ballasted down by flooding tanks two and five until their drafts had increased by three feet. The outboard hydraulic puller was then used to place the maximum tension on the outboard wire. This produced an outboard list on the barges of about 5 degrees. The inboard hydraulic pullers were then operated until 10,000 lbs. of tension was placed on each of the inboard wires. The barges were then de-watered. The barges returned to a 5 to 8 degree inboard list. All attempts to take in wire with the inboard hydraulic pullers only resulted in increasing the list on the two barges to about 20 degrees. At that point, the maximum tension from each puller was attained and no further progress was achieved.

3-5.1.3 Stability. One of the main concerns was the stability of the barges. If the counter wire running over the outboard side of the barges parted while WENDY was suspended, the full load would be held by the inboard wires. Based upon the POSSE model for the barges (Appendix O), 120 tons was the maximum side loading which could be sustained by the barges and remain stable. As the maximum dynamic load for the pullers was 50 tons each, 100 tons was the limit for the applied load. The additional load applied to the

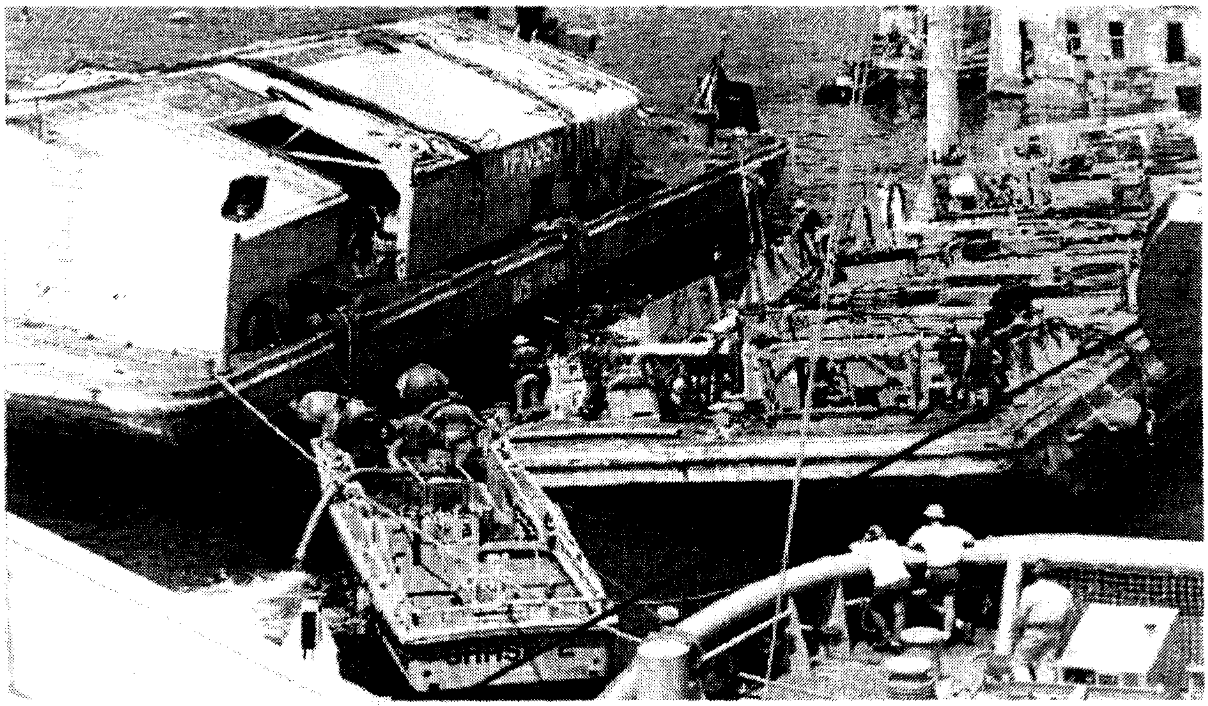

Figure 3-32. Hydraulic Puller Configuration on Barges for Heavy Lift Attempt.

inboard wires due to a failure of the outboard wire was estimated at 15 to 20 tons once WENDY had been raised more than 5 feet off the bottom. The reason for this low figure is because of the multiple friction points over which the counter wire passed. Although the hydraulic puller would exert up to 50 tons of force, the actual load seen by WENDY would be much less. This was confirmed by the tension readings of the inboard wires.

3-5.1.4 Structural Strength. The structural loading of the barge due to the outboard wire was of concern. The wire tended at a hard angle and the side loading was substantial. Slicing stress for the expected loading, as calculated using the method of Appendix B, was just at the failure level. To minimize the potential for the wire to slice through the barge hull, a doubler plate of 5/16-inch plate was welded onto the barge hull at the turn of the bilge. The inboard wires presented no problem as their loading would tend away from the YFN as the barges listed while picking up WENDY.

3-5.2 WENDY Configuration. WENDY rested on the sloping bottom with her bow fully submerged and her stern awash. Depth of the water was 48 feet at the bow and 10 feet at the stern. WENDY pierced the surface of the water at the forward most extent of the superstructure. Divers reported her stern two feet above the bottom and the bow just touching the bottom when the stern was fully de-watered. With the stern fully flooded, the stern was solidly on the bottom penetrating slightly into the silty floor while the bow was two to three feet off the bottom. These conditions produced the initial bow lift plan (Appendix K) which attempted to take advantage of this fulcrum effect. When the fulcrum attempt failed, the additional 40-50 Ltons of lift required was to be provided by GRASP (Appendix L).

3-5.2.1 WENDY Forward Compartments. Pumps and an air hose to the forward compartments remained in place and were used to attempt the de-watering of the spaces. De-watering these spaces was vital to the re-floating effort as the initial de-watering attempt was expected to produce roughly 130 tons of buoyancy. The total de-watered buoyancy of the forward compartments was roughly 150 tons.

Initially, a single six-inch diesel driven pump was used in conjunction with the air hose. After it was determined that no progress was being made, an additional 6-inch hydraulic submersible pump was installed but it also failed to overcome the leaks that were present. With each lift attempt, additional efforts were made to locate and secure leaks into the forward compartments, however, no significant reduction in flooded volume was ever identified. As a result, insufficient lift was obtained to lift WENDY's bow to the surface.

3-5.3 Pivot WENDY Bow Lift. Based upon divers' surveys, the pivot point for WENDY was estimated at roughly 35-50 feet forward of the aft perpendicular. Using POSSE (Appendix K), it was determined that by fully de-watering the engine room and leaving the remaining aft compartments flooded, the bow would require a 200-ton lift to bring it to the surface. At that time, the forward compartments would be dewatered and the main deck would then be awash.

It was important to ensure the pivot point on WENDY did not move aft and reduce the fulcrum effect beyond the point at which the barges could not produce sufficient lift. Divers worked to scour the bottom from underneath the stern to a maximum depth of five feet below the existing bottom. As the divers worked, the bottom became increasingly hard and consisted more of coral and rock than sand and silt. As a result, the divers were unable to achieve any significant additional clearance.

Although it was realized that the pivot point could not be maintained, the attempt to lift WENDY's bow with this configuration was executed anyway. The result of the lift indicated no significant movement of the bow.

The loss of the fulcrum point meant that the bow would not surface with the lift available. The failure to obtain any significant movement of the bow was determined to be a result of two problems. First was the failure to pump the forward compartments. This resulted in a loss of 130 tons of anticipated lift. Second was the loss of lift force, at least 50 tons, due to friction where the dynamic lift cables went over the side of the barges. Although 5/16-inch plate was used to create a radius of 18 inches or more and grease was applied to the surface in contact with the cables, it was evident from grooves cut into the plate by the cable under load that significant energy was being lost to friction. Rollers were needed to overcome this problem but were unavailable.

3-5.4 USS GRASP Heavy Bow Lift Configuration. GRASP was configured for a heavy bow lift over the starboard main roller. A hydraulic puller was rigged through a sliding block and the block was attached to the 2 1/4-inch lift chain as shown in Figure 3-33. This configuration could provide a maximum of 100 tons of dynamic lift, although the main roller is rated at 75 tons. GRASP was ballasted down by the stern to achieve the maximum clearance and lift height possible. GRASP's position was controlled with an anchor set astern and run to the auxiliary tow capstan. The anchor prevented GRASP from riding over WENDY's bow during the heavy lift.

Initially, GRASP ballasted down by the bow. This would allow GRASP to apply a greater lifting force, although limited to a short lifting height by shifting ballast aft. Once the bow of WENDY broke the surface and some of the ship's weight rose above the surface, the ballast would be transferred which would raise the bow further.

3-5.5 Non-Pivot WENDY Bow Lift. In the non-pivot lift attempt, GRASP was used to provide an additional source of dynamic lift as discussed in 3-5.2. The two barges remained attached to WENDY as in the previous pivot lift attempt and the effort to pump the forward compartments continued.

With the maximum lift obtainable from the barges and GRASP, the bow of WENDY only raised 3 to 4 feet from the bottom. Again the main cause for the failure to lift the bow was the inability to de-water the forward compartments.

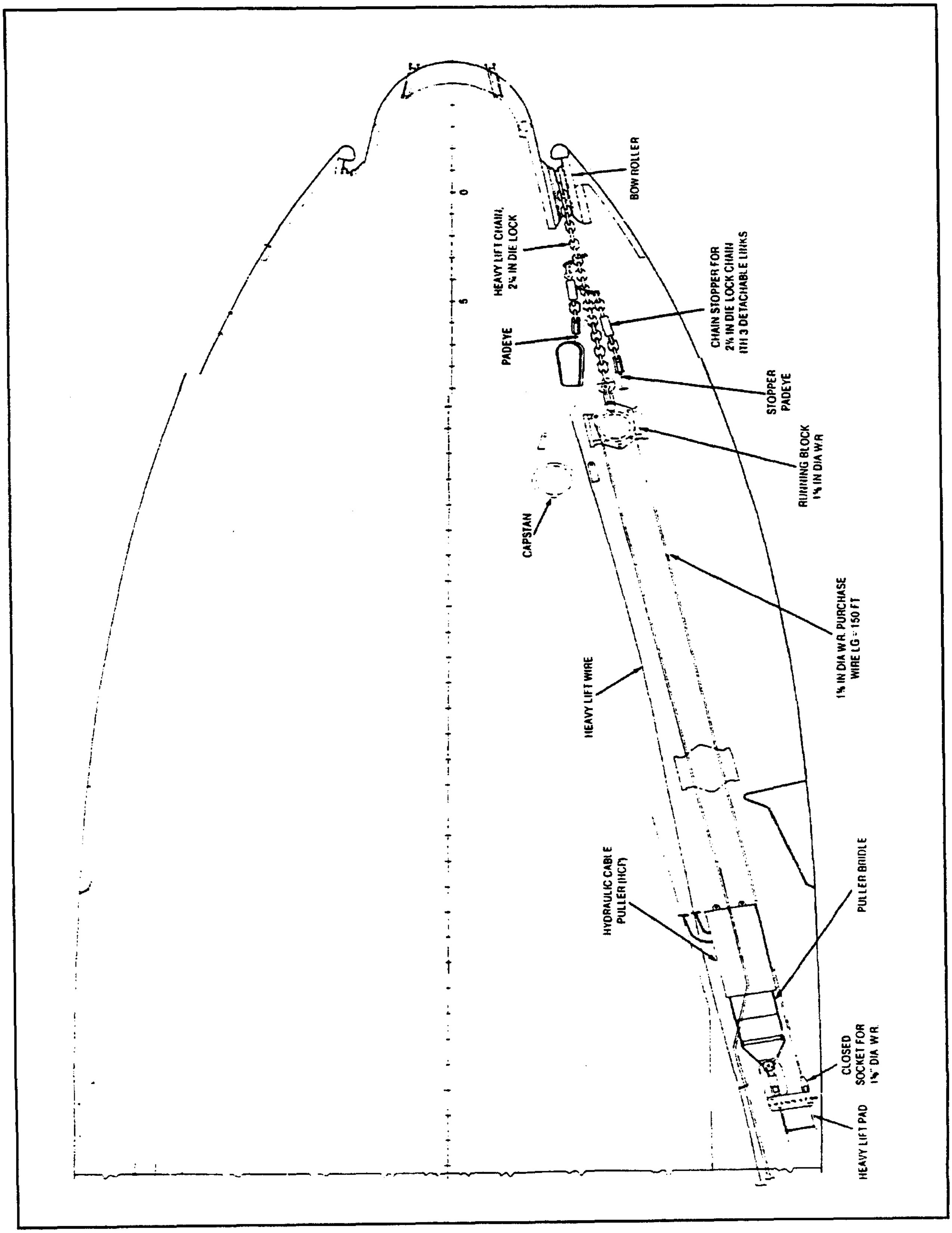

Figure 3-33. USS GRASP Heavy Bow Lift Arrangement.

After the attempt to lift the bow with GRASP, divers conducting another survey to identify leaks in the forward compartments noticed cracks forming at main structural points on the forecastle deck where it joins the hull. Based upon these findings, it was decided to abandon any additional attempts to lift the bow using a double bow lift from GRASP.

3-6 PHASE V: WENDY REMOVAL. With the discovery of the cracks occurring at various points on the forecastle of the ship around the lifting points and hull welds, any thought of conducting additional lift attempts, especially at increased loads, was considered unsafe. As a result, a heavy lift plan with a single barge forward with lift wires cradling WENDY was developed.

3-6.1 WENDY Configuration. For the final phase, no additional work was done to WENDY. The only activity involved was the de-watering of the aft compartments to ensure the maximum buoyancy was present for the extraction. Appendix M shows the POSSE model for this configuration.

3-6.1.1 Compartments. To achieve the minimum weight to be supported by the lift barges, all compartments aft were to be de-watered and maintained dry by the use of a 4-inch submersible electric pump. The main cargo and forward compartments remained fully flooded.

3-6.1.2 Stability. With the forward most wires affixed directly to the chain hawsers on WENDY, there was no chance of the ship rolling within the cradle created by the lift wires. With the forward section of WENDY suspended underneath the YC, the center of gravity was about 30 feet below the barge. With the center of buoyancy of the barge being located above the effective KG, the result was a positive stability condition. The freeboard and the beam of the barge combined to provide additional reserve stability to ensure the ship and barges would not roll due to wind and sea action.

With the stern of WENDY fully de-watered, there would be no free surface effect. In addition, the fullness of the stern would provide additional stability.

3-6.2 Barge Retraction Configurations. The barges were both re-configured as lift craft. The success or failure of this attempt would depend on the ability of the barges to lift and support the entire weight of WENDY.

3-6.2.1 YC. The YC was the primary lift craft. It would have to support the entire weight of WENDY's forward section. The wires supporting WENDY from the YC would have to withstand the additional loading produced by the action of the seas during the transit to the disposal site.

3-6.2.1.1 Configuration. To lift the bow which was estimated to weigh 300 tons, each wire would carry 30 tons if equally loaded. The dynamic loading for sea state and uneven loading of the wires was estimated to place the expected load seen in the wires at close to the breaking strength of the wires. Use of chain as the primary lift bridle was considered but the problems and time required to run only chain and the difficulty in devising a means to safely cut the chain at sea to sink the WENDY resulted in the decision to use the wire. Two separate 2 1/4-inch chain bridles (Figure 3-34) were rigged as secondary bridles to attempt to hold WENDY should the wires part prior to moving WENDY into sufficiently deep water to clear the harbor.

Each wire was attached at one end directly to the main padeyes located centerline on the barge. The other end passed through a wire stopper which was also connected to the same padeye as shown in Figure 3-35. The use of the wire stopper allowed the wire to be pre-tensioned to ensure that all slack was taken up and the loading on each wire was as even as possible. Cutting charges were then placed to sever each wire once the ship had been towed to the desired disposal site.

Except for the wire, chain, tackle and cutting charges, all other equipment was removed from the barge as can be seen in Figures 3-36 and 3-37.

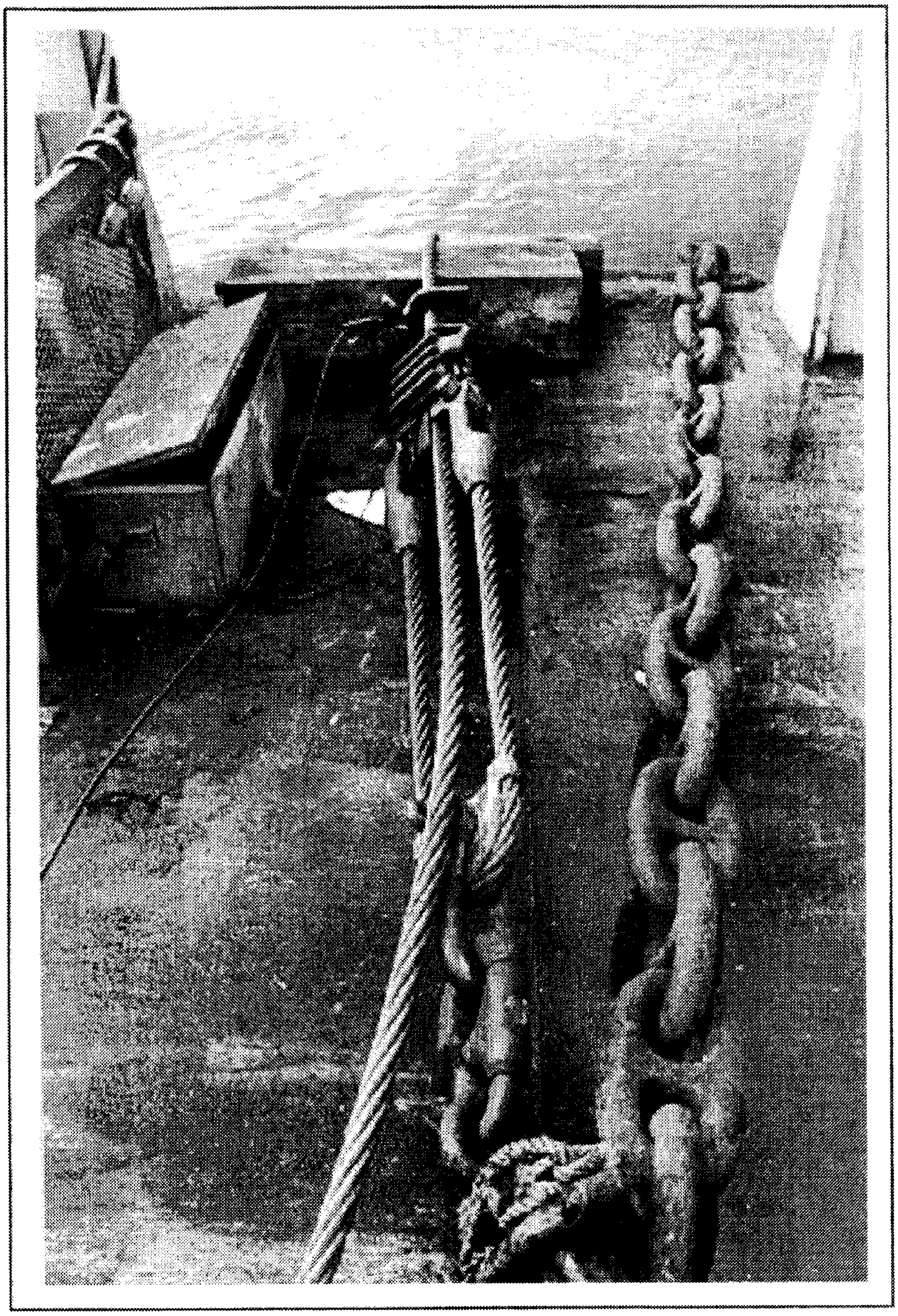

Figure 3-34. Topside View of YC Rigged with Wire and Chain to Support the WENDY.

3-6.2.1.2 Ballasting. To provide the lift to raise WENDY off the bottom, tanks 2 and 5 followed by 3 and 4 of the YC were flooded down. Each tank provided approximately 120 tons of ballast The wires were then pre-tensioned using the hydraulic pullers on the YFN which was alongside. The pumping sequence for de-watering the tanks was 3 and 4 followed by 2 and 5. This sequence provided a minimum of free surface effect and distributed the load seen by the YC structure more evenly as shown using POSSE. Three-inch diesel-driven salvage pumps were utilized to flood and de-water the tanks.

Tanks 3 and 4 were pumped dry the evening before the attempt to move WENDY. Tanks 2 and 5 were left full to ensure that WENDY would not move during the night. The following morning, the YC was fully de-watered and all remaining equipment was removed from the barge.

3-6.2.1.3 Stability. POSSE was used to analyze the barge stability at various loading conditions prior to rigging to ensure that the YC would remain stable throughout the ballasting sequence and transit.

3-6.2.1.4 Structural Strength. The only areas of concern regarding the structural strength of the YC were the barge edges where the lift wires passed over the corners. To ensure that both the lift wires and the barge structure were not damaged, 8x12x36-inch oak docking block caps were placed between the barge and the wire as shown in Figure 3-8. The oak crushed under the loading but provided a larger radius and greater strength to handle the load.

3-6.2.1.5 Explosive Charges. Once WENDY had been towed to the intended disposal site, the wires supporting WENDY from the YC would have to be cut simultaneously to prevent damaging the barge. Also, a method would be required to release WENDY quickly should anything go wrong during the tow which might endanger personnel or the YC. The only method which provided a high degree of success and a minimum risk to personnel was explosive cutting charges.

Figures 3-34 through 3-36 show the placement of charges on the YC. Charges were placed after the YC had been fully pumped and all equipment removed from the barge. Only the demolition crew remained on board the YC during the tow.

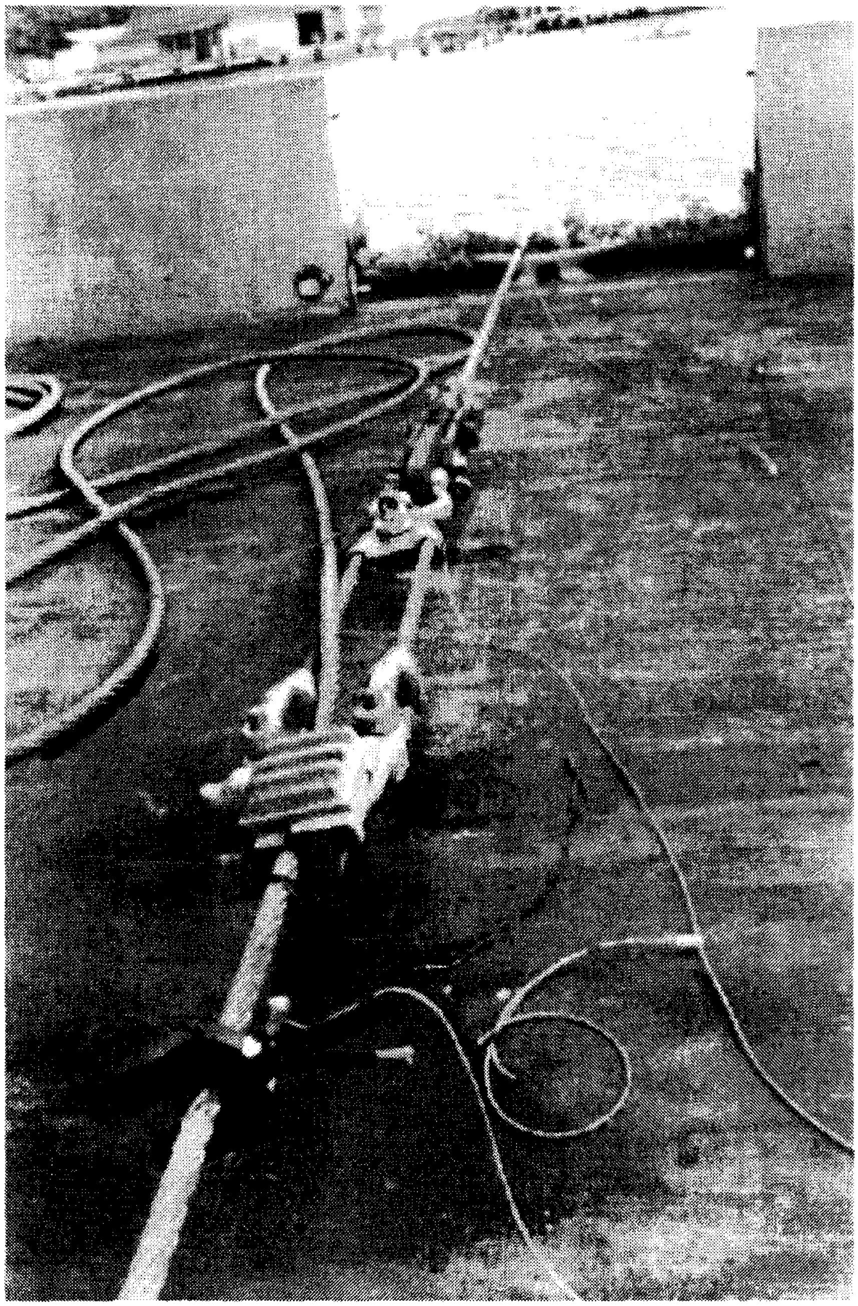

Figure 3-35. Topside of YC Showing Wire Stopper and Explosive Wire Cutter Configuration.

3.6.2.2 YFN. Based upon the estimated weight of WENDY and the buoyancy provided by the YC and the de-watered compartments, it was calculated that WENDY should float at a reasonable draft aft of about 17 feet. This would provide a reasonable freeboard of 6 feet to the main deck. However, with the concern over the accuracy of the model, an additional buoyancy source was desired to ensure that the stern had sufficient buoyancy and freeboard.

3-6.2.2.1 Configuration. The YFN was attached to the stern of WENDY using two of the 2 1/4-inch chains previously rigged to WENDY's stern. Each chain was attached to the main padeyes located on the

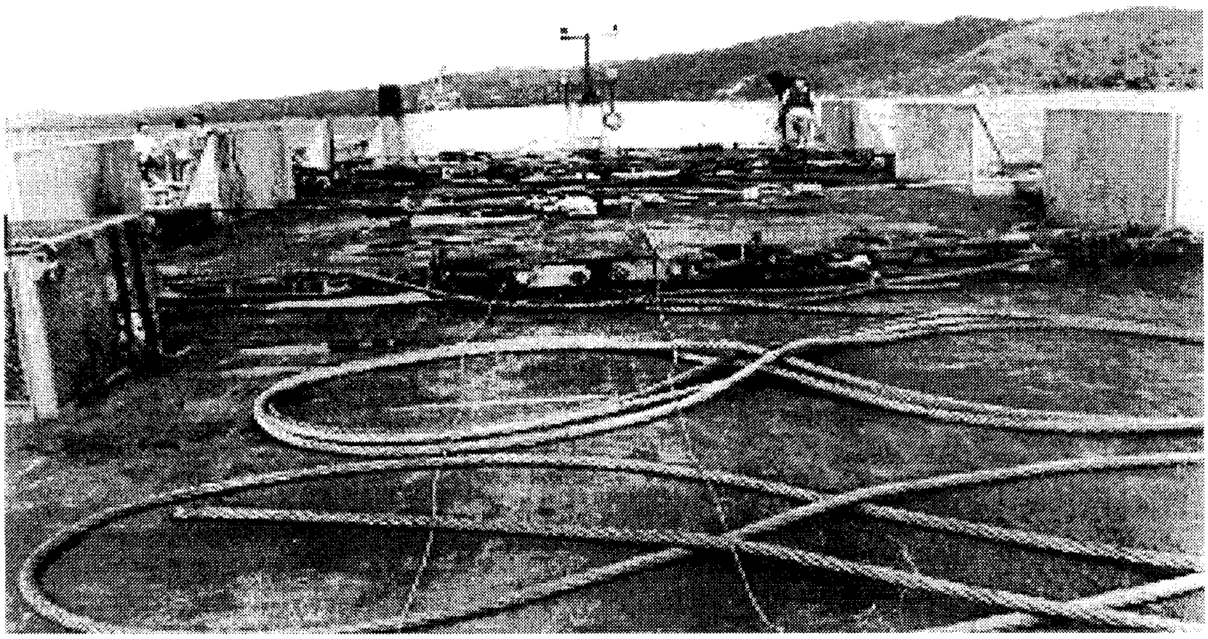

Figure 3-36. View of YC Rigged w/ Chain and Wire Bridle.

centerline of the YFN via a pelican hook to provide a rapid break-away release if required. Several padeyes were strapped together with 5/8-inch wire to provide backup should the load break one of the padeyes. The chains were rigged to place the YFN in direct lift of WENDY's stern.

3-6.2.2.2 Ballasting. In order to provide a greater lift capacity without encountering an excessive trim, tank 6 on the YFN (stern of the barge) was filled with water. In the ballasted condition, without the weight of WENDY, the YFN would be trimmed by the stern. The trim with the maximum anticipated weight of WENDY carried at the bow of the barge would result in roughly a neutral trim condition.

As it turned out, the POSSE model prediction (Appendix M) was about 50 tons heavier than actual. Before the YFN could be fully attached to WENDY, the final pumping of the YC was nearing completion when it was determined that WENDY was floating free. The POSSE model predicted that a small ground reaction of about 50 tons would remain after the YC was fully pumped.

3-6.2.2.3 Stability. POSSE was used to analyze the barge stability at various loading conditions prior to rigging to ensure that the YFN would remain stable throughout the ballasting and transit periods.

3-6.2.3 GRASP Retraction and Tow Configuration. GRASP would be required to perform two separate evolutions during this final phase of removing WENDY from Coxen Hole. First, the POSSE model predicted that with the YC providing 300 tons of lift and all aft compartments pumped, there would still be a ground reaction of about 50 tons. To overcome the resulting force which would be holding WENDY aground, GRASP would have to be rigged to pull her off. Once WENDY was floating free, GRASP would have to shift into a towing configuration and tow WENDY to the disposal site (Figure 3-37).

3-6.2.3.1 Retraction. The retraction would have to be done in such a manner to ensure that WENDY would not break free and either slam into the back of GRASP or run aground again on the surrounding reefs or shallows.

To accomplish this, the anchor that had been set astern of GRASP was run to one of the auxiliary tow winches. The winch could then be used to take a strain on WENDY with sufficient force to free her. However, the pull would be controlled and would produce a minimum motion of WENDY once the ground reaction was broken.

While taking up slack and applying the initial tension to WENDY, she floated free and GRASP proceeded to the final phase.

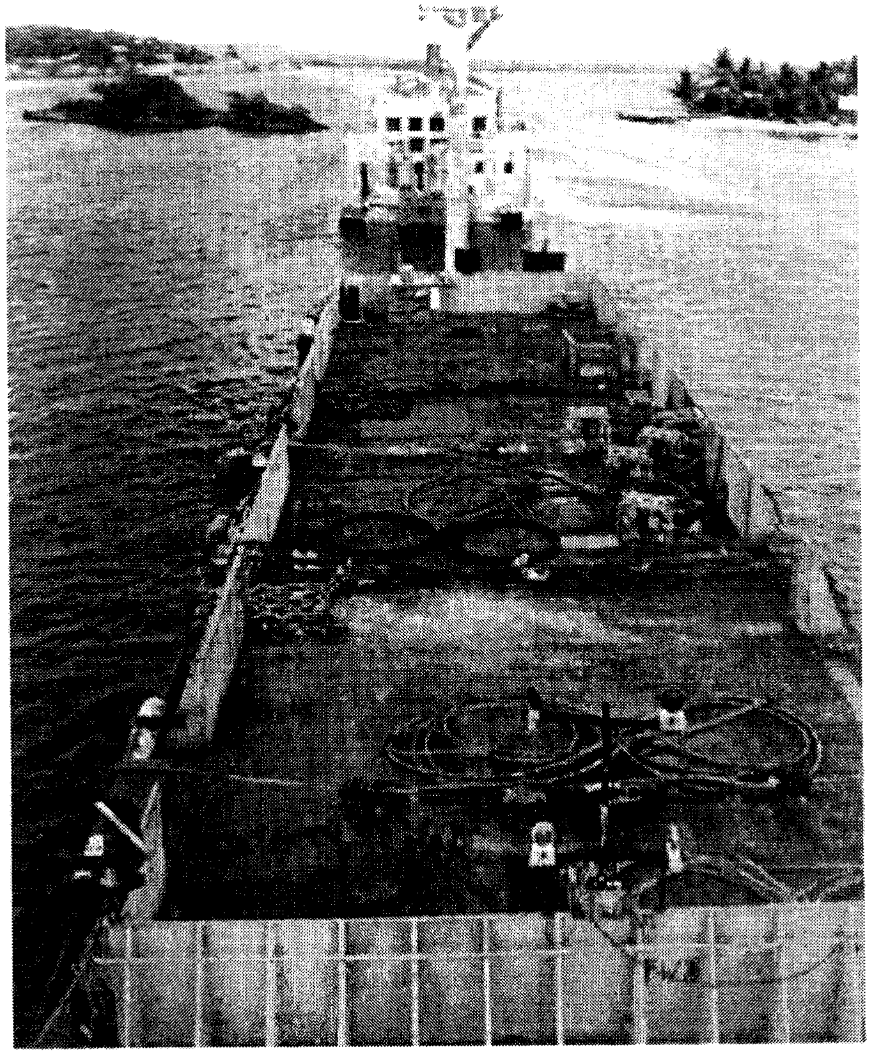

Figure 3-37. View of YC and WENDY Ready for Retraction and Tow.

3-6.2.3.2 Tow. Once WENDY floated free, GRASP took in the stern anchor and passed its tow wire to the attachment point on the YFN. GRASP then pulled WENDY out of the harbor (Figure 3-38) and westward around the leeward side of Roatan.

Beam and quarter swells caused several extreme twisting oscillations of the YC and the YFN during the tow resulting in one set of wires on the YC parting soon after clearing the harbor. As a result of the damage being inflicted on the YFN by WENDY's stern, the chain passing from the YFN to WENDY was released and WENDY was towed from the YFN on synthetic line. After one particularly large swell was encountered while rounding the western tip of Roatan, the power cable connecting the 30kw generator on the YFN to the 4-inch submersible pump in WENDY's engine room failed and the engine room began taking on water. The order was given to trip out the 2 1/4-inch chain bridles on the YC and to stand by to cut the remaining lift wires.

Shortly after the de-watering pump in the engine room failed, at LAT 16°-17.9'N/LONG 086°-37.2'W, a squall passed just forward of the tow. The resulting larger seas and the additional water weight in the flooding engine room caused the stress on the remaining wires from the YC to WENDY to exceed their breaking strength. The wires parted and WENDY slipped below the water within 15 seconds. WENDY's final moments are shown in Figures 3-39 thru 3-41.

Figure 3-38. WENDY Under Tow as Viewed from YFN.

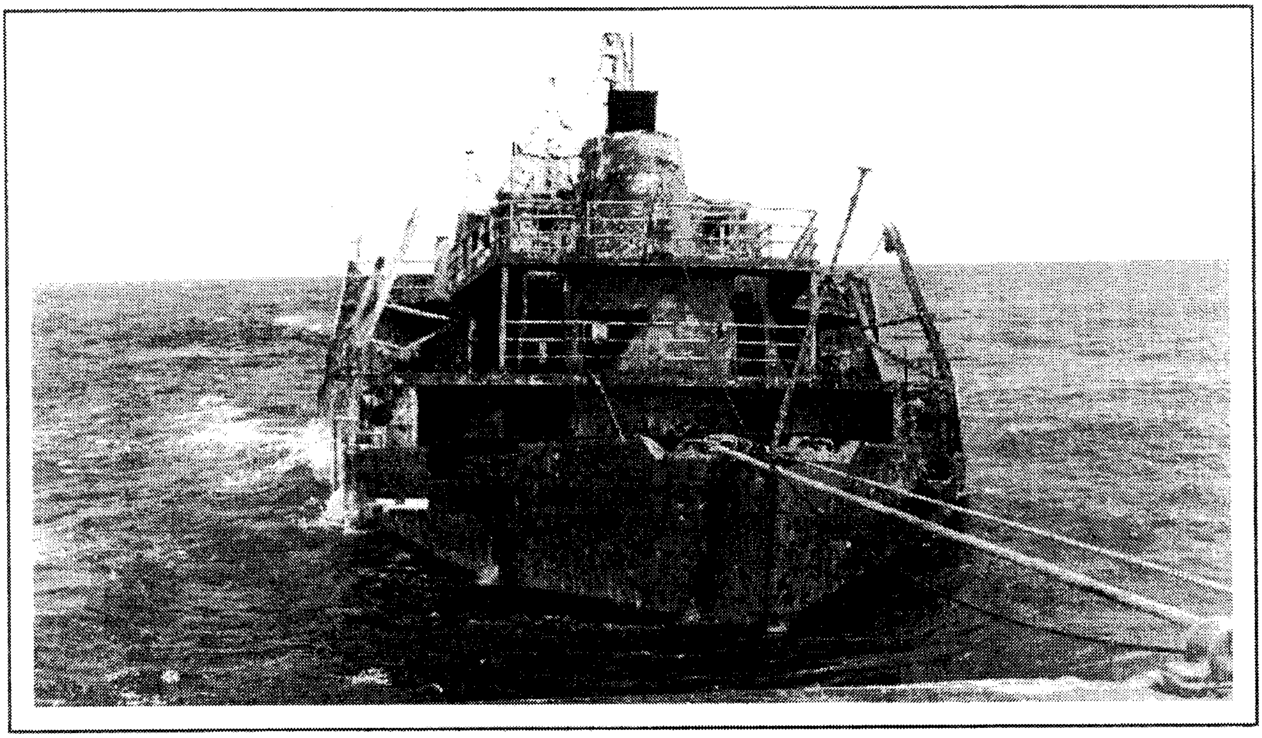

Figure 3-39. WENDY Under Tow as Viewed from YFN.

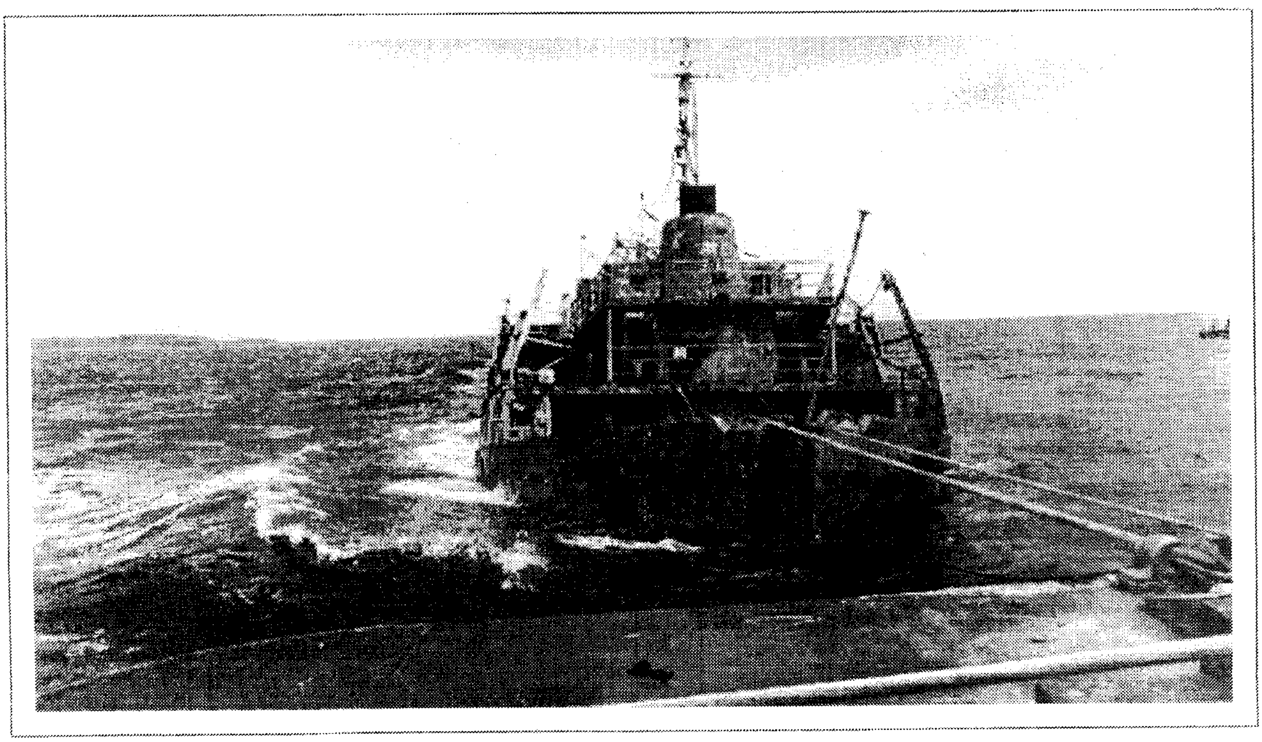

Figure 3-40. WENDY Under Tow as Viewed from YFN.

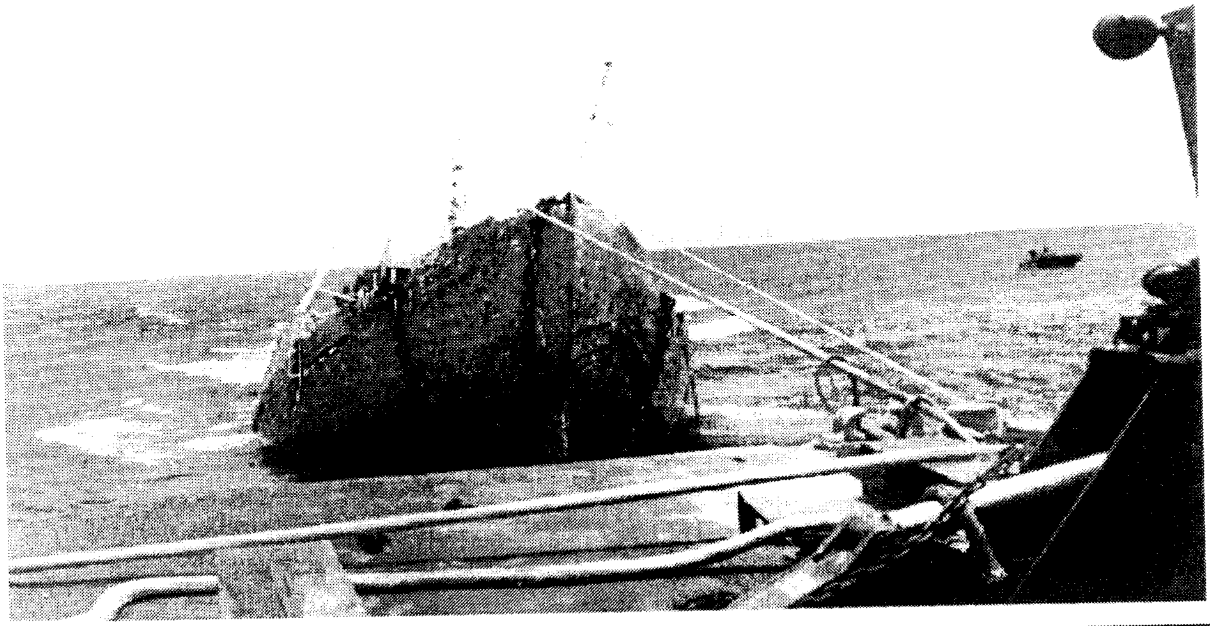

Figure 3-41. WENDY's Final Moment.

CHAPTER 4

LESSONS LEARNED

This chapter discusses the various lessons learned during the salvage of WENDY and recommendations for future salvage missions involving vessels under similar conditions.

4-1 SALVAGE BARGES, YC AND YFN

4-1.1 Inventory of Barges for Salvage Use. The use of the two barges during the salvage of WENDY was instrumental to completing the mission. They were indispensable from the initial departure from NAB Little Creek, Norfolk, VA until their return. As such, the strongest recommendation is to obtain and position several barges in close proximity with ESSM gear or areas determined to be critical for maintaining a salvage presence. Barges are inexpensive to operate and maintain, requiring little exterior and almost no interior maintenance when laid up. Maintaining the exterior preservation would be the largest expense and this cost is minimal due to the flat nature of a barge surface. The following justification and recommendations for modifying the barges are presented.

4-1.2 Transportation of Salvage Equipment. The barges provided a stable platform capable of transporting large and heavy pieces of salvage equipment. If additional stowage is required, an access could be made in the barge deck to allow for the stowage of equipment within the skin of the barge. Although lacking the speed of an airlift, the cost is significantly less and easily justifies their use when a rapid response is not required. The barges are readily towed by any salvage ship with minimal preparation.

4-1.3 Use as a Salvage Platform. The YC and YFN provided a large flat surface upon which to work. It can provide an open unencumbered work area free of the routine distractions and limitations of working on the fantail of a salvage ship. Equipment loaded on their deck can be moved around relatively easily. Due to their low height, the booms on a salvage ship can easily provide lifting services, they can be used as a dive platform and can be easily accessed by small boat. The draft of the barges was also extremely small. Fully loaded for transit, the drafts were roughly 3 feet 3 inches. This would allow the barges to be transported to sites that cannot be reached by an ARS or T-ATF and yet provide substantial capability for salvage.

4-1.4 Recommended Modifications to the Barges. To enhance the barges' ability to handle various salvage conditions, the following recommendations are made.

- **High Strength Padeyes**: In addition to the padeyes installed on the YC and YFN used during the salvage of WENDY, additional padeyes should be installed about three feet inboard of the deck edge and parallel to the padeyes which were used. This would have simplified securing the hydraulic pullers and could have been used for various rigging jobs over the side and across deck.
- **Added Strength**: The outboard deck edge outboard of each installed padeye should be strengthened to increase the load that can be supported without buckling the deck. This recommendation also applies to the outboard bulkhead which is also subject to buckling under intense loading.
- **Centerline Tank Bulkheads:** To increase stability and allow for listing of the barge, the tanks should have a centerline bulkhead installed. In the event of a hull breach, the effect on stability and draft is minimized.
- **Cable Rollers:** To reduce friction losses as lifting cables go over the side, a cable roller system should be available for installation. These would be integral with hydraulic pullers installed as we had for the salvage of WENDY.

- **Capstans:** A single portable capstan which was powered by an ESSM hydraulic power unit was installed on the YC and YFN. These units proved to be worth their weight in gold. Every barge handling evolution was greatly enhanced not only from a time saving standpoint but more importantly from a safety standpoint. These benefits would have been even more evident if inclement weather or tidal currents had been present. It is recommended that two of these capstans (one on the bow and one on the stern) be installed instead of just one.
- **Crane:** The YFN had a 20-ton Grove crane secured to the deck. Like the portable capstans, the crane proved to be an asset well worth the effort required to transport it to the salvage site. Frequent lifts of salvage equipment too heavy or cumbersome to safely and quickly handle by manual labor was made short work of by using the Grove. This asset would be lifted or driven on and is not to be permanently installed. An adequate supply of repair parts and a mechanic is recommended as Public Works is not normally available during a salvage operation.
- **Pumping Equipment:** To flood down and de-water the tanks on the barges, three- and six-inch salvage pumps were used. Although this worked flawlessly, an installed piping system in each tank would greatly enhance this process. The three-inch pumps proved adequate but four- or six-inch pumps are recommended for each tank if time is a concern.

4-2 SALVAGE GEAR

4-2.1 ESSM Gear Reliability. The salvage gear proved to be quite reliable. The only failure occurred to a six-inch hydraulic pump which blew a seal. The only possible improvement which may have prevented this casualty would be to ensure that the pumps are overhauled prior to deployment. The remainder of the equipment proved to be rugged, reliable and easy to operate.

4-2.2 Salvage Pump Considerations. Because of the head height encountered here and on other salvage missions in the past, it is recommended that hydraulic and electric submersible pumps be the primary issue pump instead of the diesel driven pumps. Setup of the submersible hydraulic and electric pumps may take a little longer, but you get much better performance and you can pump fuel and fuel contaminated mixtures with them. Although the diesel driven pumps worked flawlessly under conditions of low head height, they require priming and are limited in suction height.

4-2.3 Reverse Osmosis Water Purification. A reverse osmosis water purification system was initially transported to Roatan by USNS MOHAWK. Although fully tested prior to transfer to MOHAWK, the unit failed to consistently make good water. Whether it was inadequate training, operator error or equipment malfunction is not known. However, this piece of equipment would have been an invaluable asset during the salvage operation. Due to the presence of raw sewage in the immediate vicinity, USS GRASP was unable to produce potable water with its system. As a result, fresh water had to be purchased and barged to GRASP. The water received was not clean and had to be chlorinated prior to use. It is recommended that these units be proved and maintained for issue as standard ESSM gear.

4-2.4 Improved Knowledge and Use of Equipment. During the early stages of the salvage there were minor delays while salvage crews searched for and learned to use the various pieces of salvage equipment. Towards the end of the mission, an obvious learning curve had been completed with each new evolution being completed much quicker than before.

The lesson learned here is that salvage of aircraft occurs frequently whereas the salvage of a vessel under these conditions is rare. As a result, aircraft salvage is polished and fine-tuned. Ship salvage on the other hand lacks the training and expertise brought about by performing these complex evolutions. Current salvage training consists of a "canned" de-stranding of a small vessel lightly run aground and always with the same scenario. It is recommended that additional salvage training be taught at 2nd and 1st class diver school and that salvage training be refined to exercise the other aspects of ship salvage.

4-3 POSSE

4-3.1 Improvements to POSSE. As noted in chapter 3, the empirical relation used in RAPID to estimate lightship weight and other ship characteristics does not hold for vessels less than 400 feet in length. There may also be other areas in which significant variations from actual ship characteristics are predicted. As such it is recommended that POSSE be updated to include algorithms which will take into account these differences. An alternative or at least a short term fix is to have POSSE provide a warning to the user when input parameters fall outside of an allowable tolerance criteria.

4-3.2 Use of POSSE. POSSE proved to be invaluable during the salvage. The value of POSSE's ability to allow the salvage engineer to perform a multitude of "what if" calculations in a short period of time and save these scenarios for future use cannot be overstated. A precaution must be exercised to ensure that a naval engineer evaluate these calculations. It is too easy to get caught up in cranking out numbers that can lead the salvage team down the path to failure. Sound engineering judgment is required to ensure that the model and the conditions applied to the model represent reality. As in the salvage of WENDY, a major portion of the model and the analysis that followed were based upon pure engineering judgment and laying one's own eyes on the actual situation.

4-4 ENVIRONMENTAL ISSUES

4-4.1 ESSM Pollution Gear. Salvage vessels are not equipped or prepared to deal with the environmental problems associated with ship salvage. An aircraft salvage has little fuel, oil, asbestos, PCBs and other environmentally sensitive materials to deal with. Should a release of these substances have occurred, the on-site ESSM pollution containment equipment would have provided the salvage team with the means to deal with the situation. To ensure future salvage operations have this capability, provisions should be made to include pollution control equipment in the initial load out.

4-4.2 Equipment Training. The on-site ESSM representative provided basic training in the deployment and handling of the equipment. However, routine training for the crews of salvage vessels and Mobile Diving and Salvage Unit personnel is warranted due to the growing concern for the environment and the complexity of the equipment employed.

4-5 DIVER TRAINING

4-5.1 Underwater Cutting. The employment of underwater cutting is difficult, inherently dangerous and requires skill to be proficient. Underwater cutting on an actual salvage job becomes even more difficult and dangerous due to the unknown conditions present. To ensure that a diver is properly trained, qualification should occur under controlled conditions such as in a tank or harbor using a training aide which is properly vented. Safety procedures need to be followed religiously with zero tolerance for deviation.

4-5.2 Topside Supervision. Due to the extremely hazardous conditions present during a salvage dive, the dive supervisor must pay special attention to the divers. Pre-dive briefs and post-dive briefs are essential for maintaining the continuity between divers, supervisors and topside personnel. A standard of conduct must be set and enforced among all members of the diver team.

4-5.2.1 Pre-Dive. In addition to the standard pre-dive checks, the dive supervisor must ensure that the diver understands exactly what his job is, how to get there, where not to go, emergency procedures and what to do if the situation changes. A review of lessons learned from previous dives should be understood by each diver.

4-5.2.2 During the Dive. During the dive the supervisor must remain acutely aware of the location and progress of the diver. The supervisor must continually monitor the well-being of the diver and ensure that the diver reports his movements and activities at all times. In the event of an emergency, the supervisor must be able to guide the diver out or the standby diver to the stricken diver, possibly by an alternate route.

4-6 EVOLUTION IMPROVEMENTS

4-6.1 YC Puller Configuration. The YC had been configured with three hydraulic pullers as discussed in section 3-4.3. A better barge rigging configuration than the one used would have been to place the pullers at positions 2, 3 and 4 rather than 1, 3 and 5. The angle at which the 2 1/4-inch chain at positions 1 and 5 pulled would have been reduced. This would have prevented some of the problems which were encountered with the chain shearing off part of the deck fairing and pulling the hydraulic pullers off their blocks. The pulling effort would also have been directed in a more direct path between WENDY and the anchors.

4-6.2 YFN Extraction Configuration. The YFN was configured to support the stern of the WENDY at the time of extraction as discussed in section 3-6.2.2. A fender system should have been placed between the YFN and WENDY to prevent the direct impact of the two vessels together. As a result, the YFN suffered some structural damage due to the sea action and the close proximity to WENDY's stern. The damage consisted of several holes located at the top of the barge rake near the deck edge. As such, no flooding of the forward tank occurred.

APPENDIX A

LIFTING BARGE PADEYE DESIGN

PADEYE DESIGN:

Figure A-1 shows the final design of the padeyes as manufactured for use on the lifting barges. The 2 1/4-inch lifting chains were attached using 65-ton plate shackles. The design of the padeyes was driven initially by the lifting barge capacities and the chain and cable cutting stresses. Available material for use in constructing the padeyes were effective in determining the material criteria. The following values were then used to design the padeyes from a BEARING STRESS failure criteria:

Ship Steel Yield (*Sy*):	34,000 psi
Thickness (*t*):	2.0 inch
Pin Dia (*d*):	2.25 inch

The maximum force (*F*) that can be applied to the padeye is then:

$$F = S_y t d = (34,000)\,(2)\,(2.25) = 153,000\text{lbs} \qquad (1)$$

Minimum Number (*N*) of wires required to lift 550 tons (dead weight limit of barge):

$$N = \frac{(550)\,(2,240)}{153,000} = 8.05\text{wires} \qquad (2)$$

Rounding up to the next pair requires 10 cables or 5 pairs of cable to achieve the lift without exceeding bearing stress criteria. By the use of 10 cables, the maximum loading per chain based upon the barge capacity is 55 long tons.

Shear tear out is prevented by placing the pin at least 1.5 diameters (3-3/8 in) from the plate edge. The padeyes were designed with pin centers 5 inches from the plate edge.

Failure due to rupture of the padeye plate itself will occur if $\sigma > Sy$.

Substituting the appropriate values into the following equation shows that the resulting stress is well below the critical value.

$$\sigma = \frac{F}{A} = \frac{(55)\,(2,240)}{(2)\left(9-2\frac{15}{16}\right)} = 9,211\text{psi} \qquad (3)$$

The only remaining failure mode is pure shear of the pin connecting the padeye to the plate shackle which is rated at 65 tons.

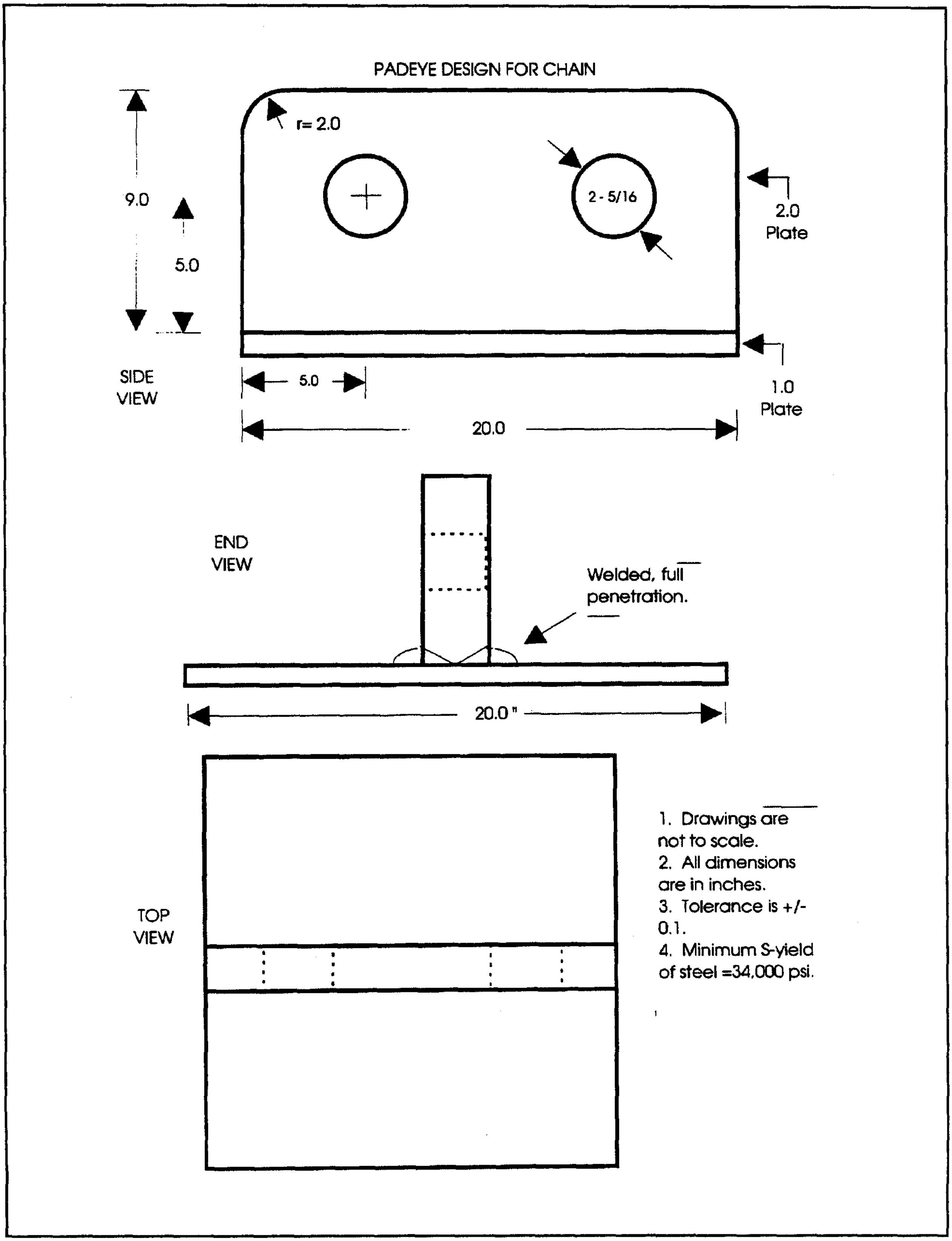

Figure A-1. Completed Padeye Installation.

PADEYE ATTACHMENT DESIGN:

The padeye will be of welded construction and the attachment to the deck will be by welding. There are two shear and one tension failure modes which must be reviewed. First the vertical plate could fail in shear where it is attached to the base plate, Second, the base plate attachment to the barge could fail in shear. Thirdly, the base plate attachment to the barge could fail in tension due to the induced moment.

The AISC criteria for welded joints as it pertains to the padeye construction is shown in table A-1.

Table A-1. Stresses Allowed by the AISC Code for Weld Metal.

Type of Loading	Type of Weld	Stresses Allowed
Tension	Butt	0.60Sy = 20,400 psi
Shear	Butt or Fillet	0.40Sy = 13,600 psi

The maximum shear stress developed in the vertical plate joint is:

$$\sigma = \frac{F}{A} = \frac{(55)\,(2,240)}{(2)\left(9-2\frac{15}{16}\right)} = 9,211\text{psi} \tag{4}$$

The area value is conservative as it only assumes the complete weld thickness is the same as the vertical plate thickness. This resulting stress is well below the maximum stress allowed as given in table A-1.

The shear stress developed in the weld joint holding the base plate to the deck is calculated in equation (5). A conservative stress value is obtained by assuming that the weld metal height is only 0.5 inches high around the entire perimeter of the plate. The resulting stress calculated in equation (5) is well below the-maximum stress allowed as given in table A-1.

$$\tau = \frac{F}{1.41hl} = \frac{(55)\,(2,240)}{(1.414)\,(0.5)\,(4)\,(20)} = 2,178\text{psi} \tag{5}$$

The stress in the weld holding the padeye base plate to the deck due to bending is determined by equation.

$$\sigma = \frac{Mc}{I} = \frac{M(1/2)}{0.707bl^2(h/2)} = \frac{1.414yF}{blh} = \frac{(1.414)\,(6)\,(55)\,(2,240)}{(20)\,(20)\,(0.5)} = 5,226\text{psi} \tag{6}$$

Figure A-2 shows the loading condition generating the bending moment stress in the weld metal. The analysis is conservative in that it does not take into account the additional strength produced by the side welds on the base plate.

Figure A-3 shows the two welds used and the dimensions for the condition analyzed. The resulting stress calculated in equation (6) is well below the maximum stress as given in Table A-1.

Based upon the design bearing stress (P) capacity of each barge; given the number of wires used; is shown in Table A-2. Equation (7) was used to determine the lift capacity for various numbers of cables.

$$P = (Sy)(t)(d)(N)/(2,240) \tag{7}$$

Table A-2. Maximum Lift Capacity of Each Barge Given the Number of Wires Used.

No. Cables	Total Capacity
4	273 Tons
6	409 Tons
8	546 Tons
10	683 Tons

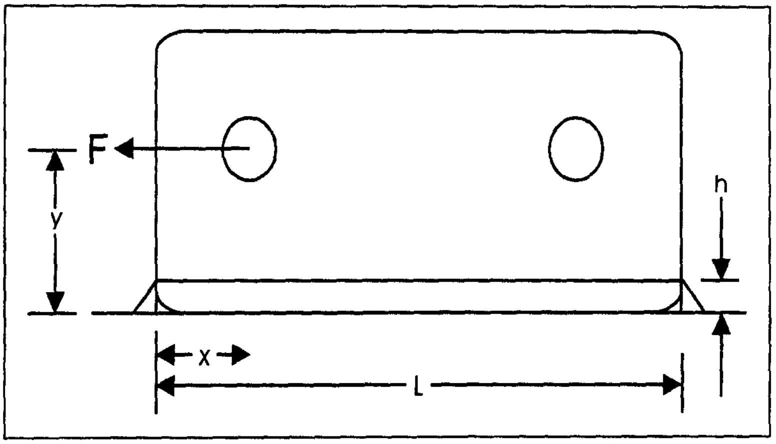

Figure A-2. Padeye Bending Movement Configuration.

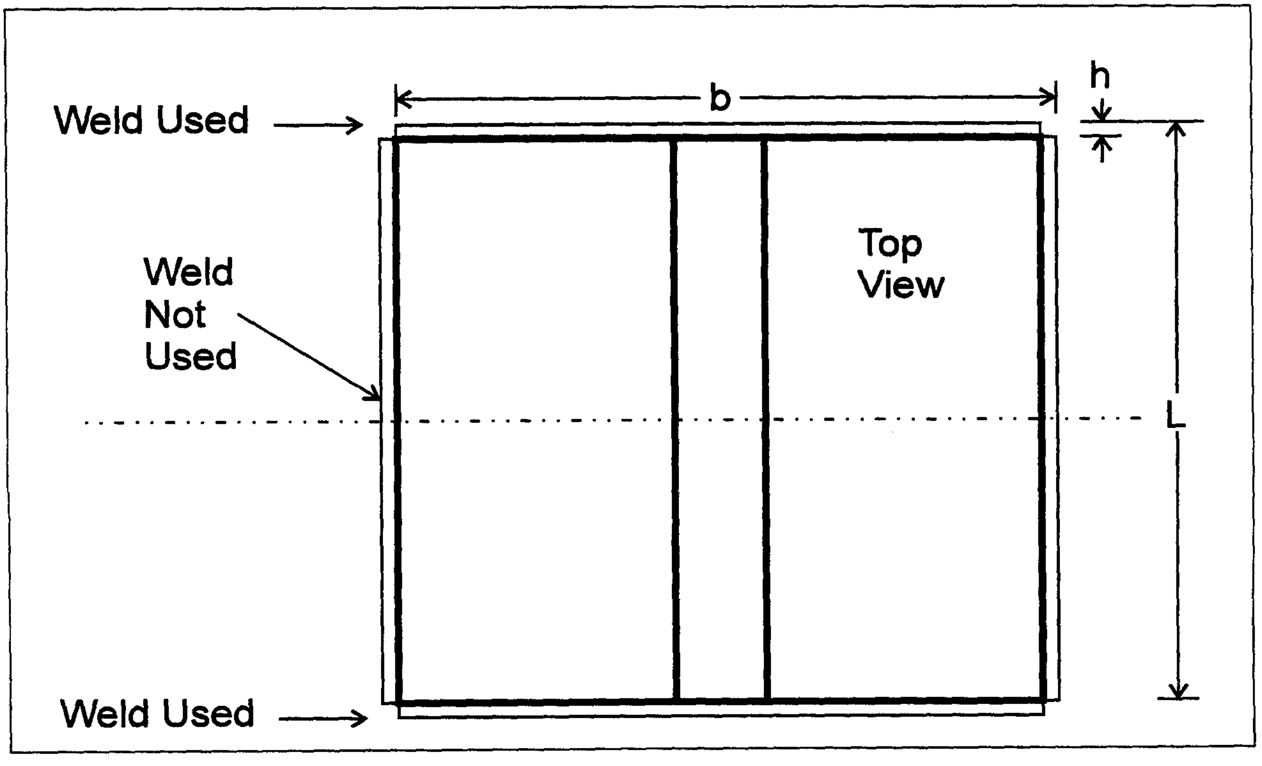

Figure A-3. Padeye Bending Stress Configuration.

APPENDIX B

CABLE/CHAIN CUTTING CALCULATIONS

To ensure the chain and cable loads present on the WENDY and the lifting barges do not result in structural failure of the hulls due to slicing, the method outlined in Ulrich et al[1] was used.

W = Wreck weight in water

T = Lift wire tension

b = Lift craft beam

d = Distance from lift craft bottom to WENDY bottom

θ = Angle between bottom of lift craft and outboard wire

N = Number of lift wire sets used

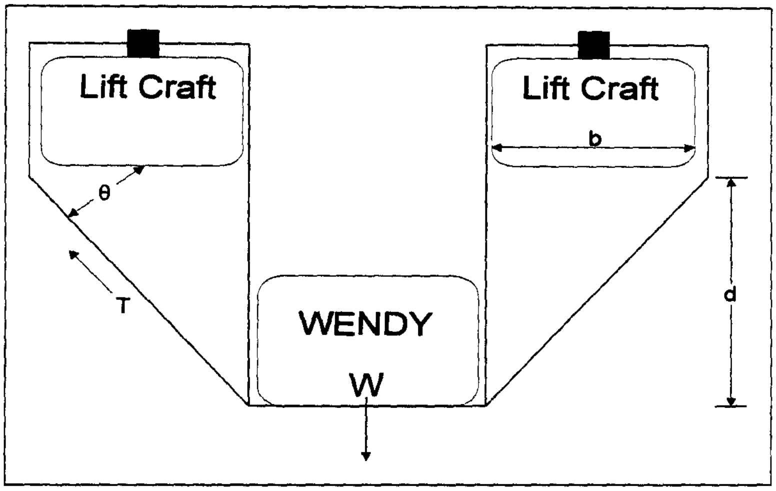

Fig. B-1. Tandem Lift Configuration.

Utilizing the notation in Figure B-1, the total chain tension as seen by the WENDY's bilge radius is determined by equation (1).

$$T = \frac{W}{2N(1+\sin\theta)} \qquad (1)$$

The tension in each chain present at the barge edge is just

$$T = W/N \qquad (2)$$

Obtaining the bilge radius (r) and the plate thickness (h), the slicing stress (σ) on the ship's structure due to the loading of the chain can be determined by

$$\sigma = T\sqrt{\frac{9.470}{r^3h} + \frac{0.203}{r^2h^2} + 2\sqrt{\frac{22.42}{r^6h^2} + \frac{0.959}{r^5h^3}}} \qquad (3)$$

1. Ulrich, Mott and Keyser, HOW TO MANAGE BARGE DAMAGE DURING SALVAGE, Ocean Industry, July, 1968

WENDY BILGE SLICING STRESS CALCULATIONS

Equations (1) and (3) are used to determine the resulting slicing stress induced in the bilge plating as a result of the heavy lift. Based upon the following values:

W	=	1,000 tons	Worst case displacement and still achieve lift.
b	=	34 ft	Max beam of barge.
d	=	15 ft	Occurs when stern deck is awash.
N	=	5 sets	All chains utilized.
r	=	40 in	Rounded down for safety.
h	=	0.2 in	Value used to account for corrosion.

The following values were calculated:

T = 71.24 tons

σ = 12,565 psi

This value is well below the 34,000 psi yield for mild steel. Working the problem backwards indicates that failure is likely at this load level if the hull plating has been reduced to 0.064 in. Diver inspection indicated significantly greater thickness was present.

LIFT BARGE DECK SLICING STRESS CALCULATIONS

We will use equations (2) and (3) to determine the resulting slicing stress induced in the barge deck plating as a result of the heavy lift. Based upon the following values:

T	=	50 tons	Maximum designed load.
r	=	8 in	Estimated resulting radius using railroad ties.
h	=	0.75 in	Accounts for deck steel, angle iron and wood.

The following value was calculated:

σ = 27,448 psi

This value is below the 34,000 psi yield for mild steel.

APPENDIX C

CARGO WEIGHT AND DENSITY ANALYSIS

To determine an estimate for the weight and density of the cargo, the type of cargo had to be determined and several estimates had to be made. The estimates made included the fullness to which the cargo hold was filled, the dry weight and volume of the cargo items and the underwater weight of the cargo items.

The type of cargo was determined by divers surveying the vessel and by information obtained from the Port operations sinkage report. The bulk of the cargo was determined to be packaged waste cardboard.

Divers also determined that the cargo had completely filled the cargo compartments. Later this was found to be slightly in error as there were several mezzanine decks that had small quantities of lumber stored within. Divers measured the dimensions of several bails of cargo and attempted to weigh them under water with a set of slings and a fish scale. This proved to be impossible as the water soaked cardboard fell apart and could not be supported by the slings. An estimate of the bail weight based upon the divers' efforts to lift the bails was obtained. Based upon the above, the information in Table C-1 was obtained:

TABLE C-1. CARGO CHARACTERISTIC DATA.

Description	Value	Units	Source
Bail Size	86x33x24	in	Divers Measurement
Cargo Hold Size	86,943	cu ft	POSSE Model
Cardboard Cargo Density	11	Lb cu ft	U.S. NAVY Salvage Manual (Strandings)
Cargo Bail Weight Under Water	150	Lbs	Divers' Estimates
Paper density	58	Lb cu ft	U.S. NAVY Salvage Manual (Strandings)

Using this information, the following characteristics were calculated:

The Cargo density can be used to determine an estimated total cargo weight for the WENDY as follows:

Cargo weight = (86,943) (11)/(2,240)
= 426.95 Ltons

Individual cargo bails were estimated with the following information:

Bail Volume = (86) (33) (24)
= 68,112 cu. in.
= 39.42 cu. ft.

Dry bail weight (min) = (11) (39.42)
= 433.6 lbs.

The minimum dry bail weight uses the cargo density value which accounts for space between cargo and between cargo and ship structure. As a result this value is probably low by about 30-40 percent.

$$\text{Dry bail weight (max)} = (58)(39.42)$$
$$= 2{,}286 \text{ lbs.}$$

The maximum dry bail weight uses the material density for paper and does not include the effect of corrugation of the cardboard and spaces within the bundles. Due to these factors the actual dry bundle weight is probably about 25-30 percent of this value.

A closer estimate for the dry bail weight is to use the estimated permeability (u).

$$u = 1 - (11/58)$$
$$= 0.81$$

$$\text{Dry bail weight (prm)} = \frac{(39.42)\ (426.95)\ (2,240)}{(0.81)\ (86,943)}$$

$$= 535 \text{ lbs.}$$

Because the permeability value includes space around the bails, a dry bail weight of 650 pounds was used as an estimate.

Under water weight of the cargo was then estimated by the ratio of submerged to dry cargo weight of the bails.

$$\text{Submerged cargo weight} = \frac{(426.95)\ (150)}{(650)}$$

$$= 98.5 \text{ Ltons}$$

A value of 100 Ltons was used for the weight added to WENDY as she rested on the bottom.

The 100 Lton value was considered to be conservatively on the heavy side as there were suspected to be areas in the hold (later confirmed by divers) that were not loaded with cargo and port operations reported numerous bails had floated away at the time of the sinking.

APPENDIX D

DUNNAGE HOLD PATCH ANALYSIS

The dunnage hold access had to be sealed to allow the compartment to be pumped. The depth of the water, about 22 feet, and the large access size, 18 x 4.5 feet, combined to make the design and manufacture of a patch a significant problem.

At that depth, the pressure acting on the plate once the hold was at atmospheric pressure would be:

$$(14.7)(22)/(33) = 9.8 \text{ psia}$$

With 84 square feet (12096 sq in) of active surface area of the plate, the resulting load which would have to be supported was 52.9 Ltons. The following calculations show the result of the final design which was to use 5/8-inch HY-80 plate and add additional support underneath the plating in the form of column supports.

From Section 2-5 of the Salvage Engineer's Handbook[1], flat plate analysis, the following equations were used for rectangular, simply supported, uniform pressure conditions:

$$\sigma = k\frac{pr^2}{t^2} \tag{1}$$

Where: σ = Maximum stress in plate
k = Coefficient from table 2-11[1]
p = Uniform pressure (9.8 psia)
r = Minor dimension of plate (56 in)
t = Thickness of plate (0.625 in)

$$\delta = k_1\frac{pr^4}{Et^3} \tag{2}$$

Where: δ = Maximum deflection in plate
k_1 = Coefficient from table 2-11[1]
p = Uniform pressure (9.8 psia)
r = Minor dimension of plate (56 in)
E = Young's modulus (30 E6)
t = Thickness of plate (0.625 in)

1. U.S. NAVY SALVAGE ENGINEER'S HANDBOOK, VOLUME 1, S0300-A8-HBK-010, Bartholomew, Marsh and Hooper, NAVSEA, 1 May 1992.

Interpolation of R/r=3.86 from Table 2-11 of Salvage Engineers Handbook[2] yields k= 0.737 and k_f=0.139. Substituting into equations (1) and (2) results in the following conditions:

$$\sigma = 58{,}000 \text{ psi}$$

$$\delta = 1.83 \text{ inches}$$

To achieve the plate size required to cover the hatch access, two plates had to be welded together. This presented a possible weak spot in the design. As an added factor of safety and to ensure that the deflection would not result in a loss of seal against the hatch coaming, six columns were installed on the underside of the plate. The columns were composed of adjustable damage control columns rated at approximately 9,500 pounds at the 9-foot length. On either end of these columns was nailed a 6-inch soft wooden cap and a 1/2-inch piece of plywood. The wood provided some crushing to allow the HY-80 plate to absorb some of the load through deflection and not transmit the full load directly to the stanchions. As designed, the buckling limit for the six stanchions was limited to 57,000 pounds, or about one-half the applied pressure load.

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2. U.S. NAVY SALVAGE ENGINEER'S HANDBOOK, VOLUME 1, S0300-A8-HBK-010, Bartholomew, Marsh and Hooper, NAVSEA, 1 May 1992.

APPENDIX E

ENGINE ROOM STACK STRENGTH ANALYSIS

De-watering the engine room was required to reduce the ground reaction to permit dragging of the WENDY into shallower water. To accomplish the de-watering, the engine room stack provided direct access to the engine room from the surface through a two and one-half foot cofferdam placed on top of the stack. The main concern with de-watering the engine room via the stack was the effect of the external water pressure on the stack superstructure. The main deck, and thus the lower portion of the stack was at a depth of 22 feet. Divers cutting holes to provide drainage from the compartments within the superstructure brought up several pieces of plate. The plate was 3/16-inch steel with 90-plus percent paint adhesion. There were indications that corrosion was occurring which was producing pitting in numerous areas. The estimated maximum pitting observed was no more than 1/16th of an inch. Divers reported stiffeners of an undetermined size spaced about every three feet.

An initial strength calculation was performed using the plate stress calculation performed in Appendix D using equation D-(1). Inserting the following data into equation D-(1), a maximum stress of 95 ksi is calculated.

For rectangular plate, uniform distributed pressure and all edges, fixed R/r = 1, from Table 2-11 of Salvage Engineer's Handbook[1], k = 0.308.

Since 95 ksi exceeds the strength of structural steel for ships, an additional analysis was performed which would include the added strength provided by the stiffeners. The method used is the effective breadth method discussed in section 2-2.2 of the Salvage Engineer's Handbook[2].

Figure E-1 shows the assumed configuration of the section analyzed. The initial information used is:

Characteristic	Raw Value	Converted Value
Depth	19 feet	p = 8.45 psia
Thickness	3/16 inch	t = 0.188 inch
Width	3 feet	r = 36 inch
Height	3 feet	R = 36 inch

Since we will be calculating the stresses produced from a uniform load, the only quantity required to use Table 2-1 of the Salvage Engineers Handbook[3] is L/B. As noted for a uniform load, L = (0.58) x span. Therefore:

$$L/B = (0.58)(96)/(36) = 1.55 \qquad (1)$$

1. U.S. NAVY SALVAGE ENGINEER'S HANDBOOK, VOLUME 1, S0300-A8-HBK-010, Bartholomew, Marsh and Hooper, NAVSEA, 1 May 1992.
2. U.S. NAVY SALVAGE ENGINEER'S HANDBOOK, VOLUME 1, S0300-A8-HBK-010, Bartholomew, Marsh and Hooper, NAVSEA, 1 May 1992.
3. U.S. NAVY SALVAGE ENGINEER'S HANDBOOK, VOLUME 1, S0300-A8-HBK-010, Bartholomew, Marsh and Harper, NAVSEA, 1 May 1992.

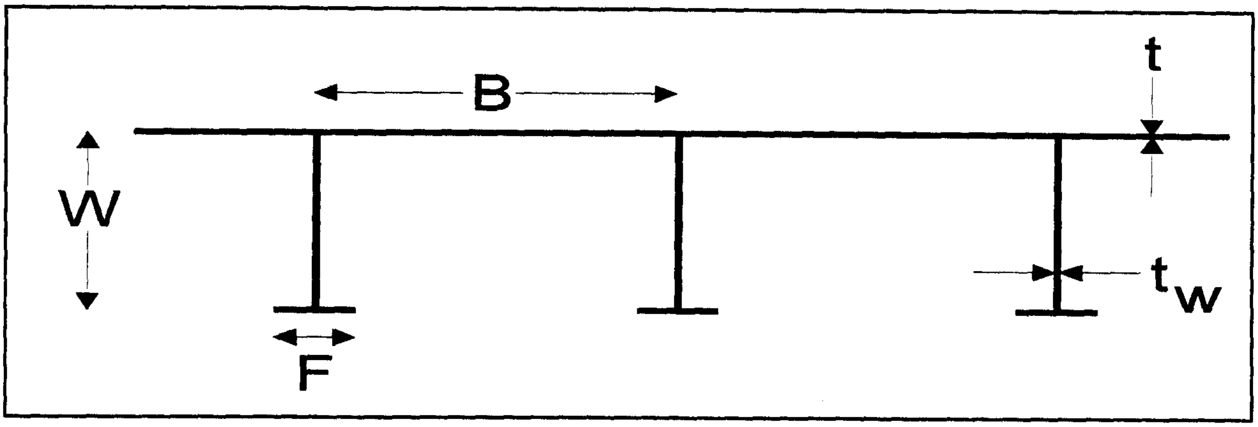

Figure E-1. Assumed Stiffened Plate Configuration.

and from Table 2-1 for single girder:

$$\lambda /B = 0.528 \qquad (2)$$

SINGLE GIRDER METHOD

The first step is to determine the effective breadth of an equivalent single girder. Inserting the value for B into equation (2) results in:

$$\lambda = (B)(0.528) \qquad (3)$$

$$= (36)(0.528)$$

$$= 19 \text{ inches}$$

Next we calculate the new moment of inertia for the equivalent girder. Table E-1 shows the table of calculations based upon the beam configuration shown in Figure E-2.

Table E-1. Moment of Inertia Calculations for Equivalent Single Girder.

#	Area	yA	In	Ar^2	I
1	(0.188)(3) = 0.564	(3.282)(.564) = 1.851	0.0017	$(0.564)(2.65)^2 = 3.96$	3.96
2	(0.188)(3) = 0.564	(1.688)(.564) = 0.952	0.4230	$(0.564)(1.054)^2 = 0.63$	1.05
3	(0.188)(19) = 3.572	(0.094)(3.572) = 0.336	0.0105	$(3.572)(0.54)^2 = 1.04$	1.05
Σ	4.7	3.139	0.4352	5.63	6.06

For a simply supported beam with a uniform load of 293.4 Lb./in (8.15 psi) (36 in), equation (4) is used to calculate the maximum moment in the beam.

The maximum stress in the beam is then computed by equation (5).

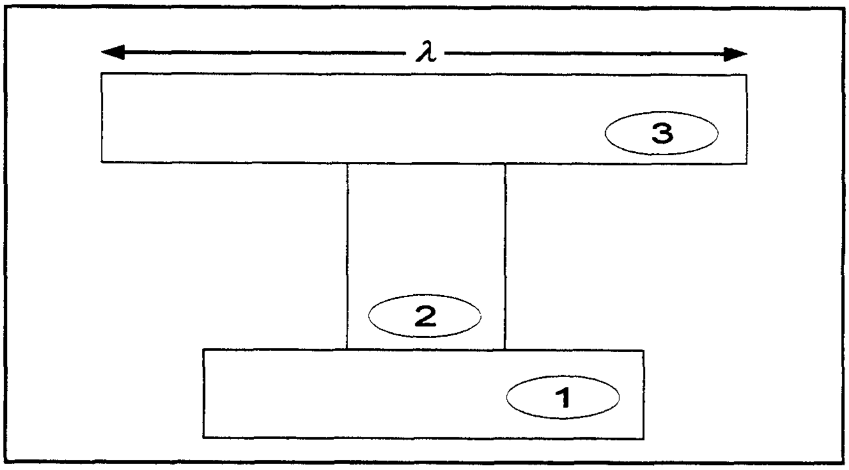

Figure E-2. Equivalent Single Girder Beam

$$M_{max} = \frac{wl^2}{8} = \frac{(293.4)\,[\,(8)\,(12)\,]^2}{8} = 338,000 \text{ in lb.} \tag{4}$$

$$\sigma = \frac{My}{I} = \frac{(338,000)\,(1.742)}{6.06} = 97.2 \text{ ksi} \tag{5}$$

The stress calculated by equation (5) is also greater than the strength of ship structural steel as calculated earlier in this section. As a result of the close agreement in the stress values calculated by the two methods, it was believed that de-watering the engine room by this method would result in the structural failure of the stack bulkhead.

The engine room was pumped using this method and the bulkheads did not fail. Inspection of the bulkheads after the engine room was dry, revealed no evidence of structural weakening due to excess loading. The stiffener spacing was only about 24 inches apart but consisted of 2-inch angle iron instead of 3-inch T. Additional strength could have been added by the additional horizontal stiffener on the compartment side of the bulkheads and the various joining bulkheads, fixtures and the complete shell structure presented by the compartment.

APPENDIX F

BEACH GEAR FORCE ANALYSIS

Figure F-1 shows the general configuration used to pull WENDY into shallower water. Three hydraulic pullers were positioned on the barge as shown in figure F-2. The wire rope from each puller was taken to a shot of 2 1/4-inch chain which was then attached to a stato anchor. The water depth of each anchor was roughly 10-12 feet.

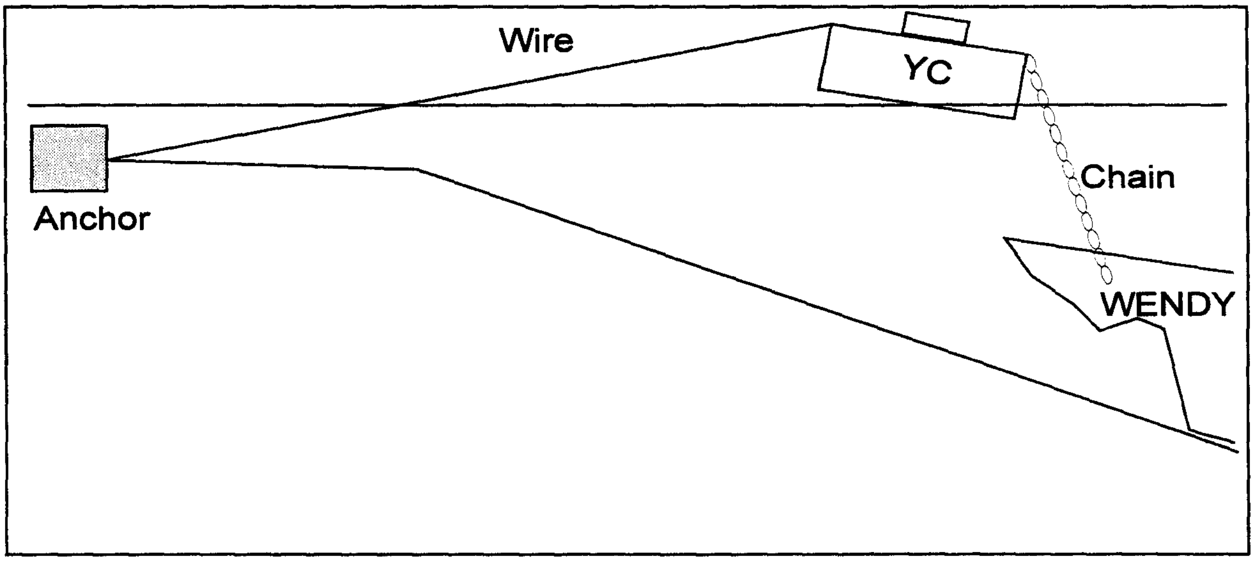

Fig. F-1. Beach Gear Configuration.

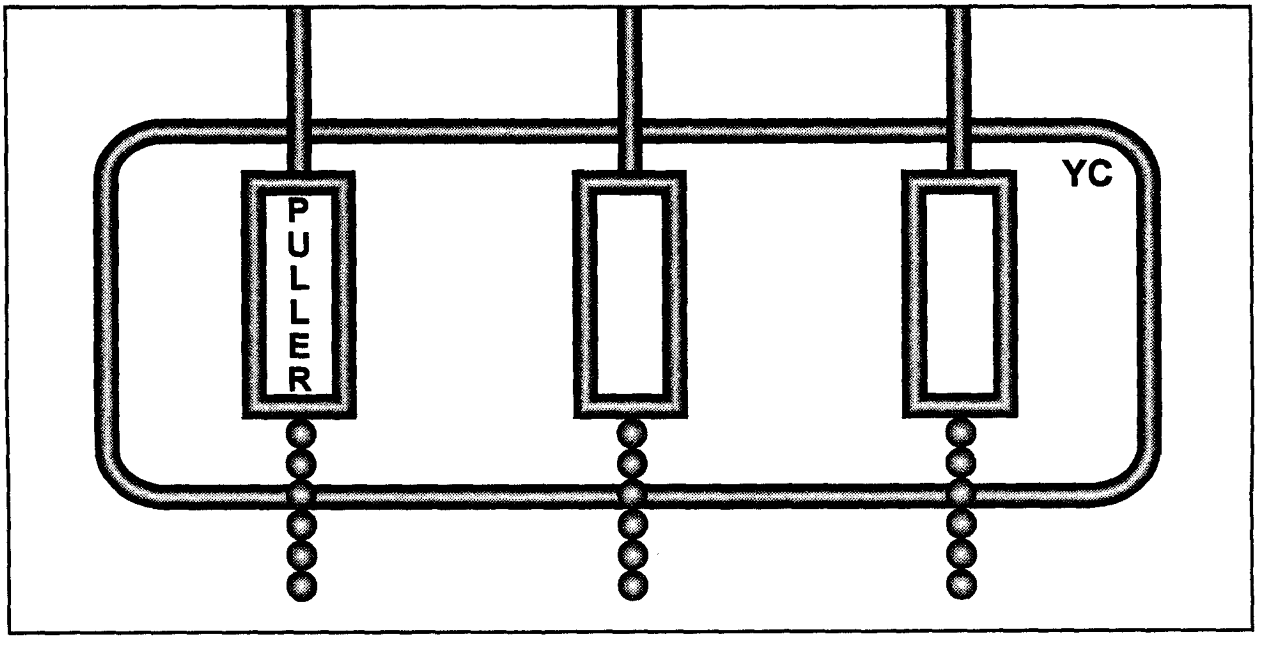

Fig. F-2. Hydraulic Puller Arrangement on YC.

Shackled to the aft end of each puller was a 90-foot length of 2 1/4-inch chain which was pulled under the stern of WENDY just forward of the rudder post skeg and then attached to a set of bitts on WENDY's main deck.

The barge itself acted as a large spring buoy. The dynamic pull of each hydraulic puller itself is limited to a maximum of 50 tons. However, by taking the maximum strain with each hydraulic puller and then locking the puller, an additional pull force could be developed by deballasting the barge. Figure F-3 shows the free body diagram for the added force analysis.

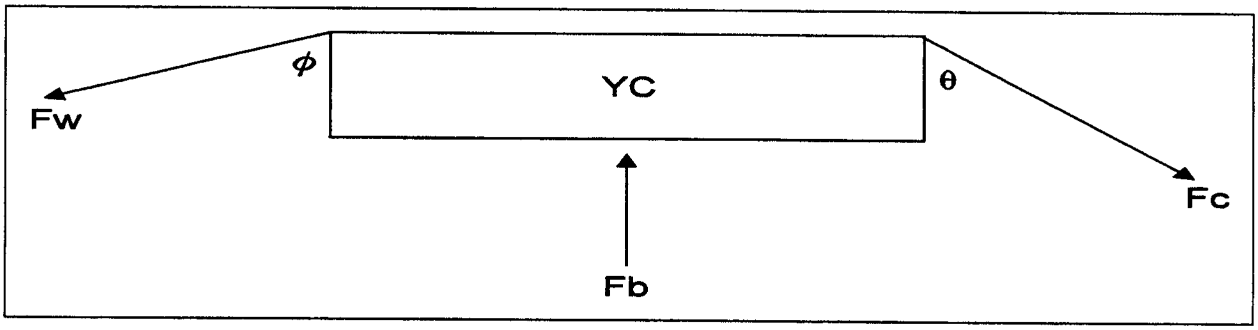

Figure F-3. Free Body Diagram for Force Analysis.

The scope of the wire rope was about 200 feet and the depth was 12 feet. From this information, the value for ϕ = 3.5 degrees was calculated but 4 degrees was used in all calculations. The value for θ varied depending on the amount of tension exerted on the chain. Forty-eight degrees was used for θ as this was about the maximum measured during any of the pulls, although initial calculations used 35 to 40 degrees.

By using the tensiometers on the hydraulic pullers, Fw was determined to be 90,000 pounds for each wire. Breaking this up into x and y components resulted in:

Fw_x = 89,780 lbs.

Fw_y = 6,280 lbs.

Since the water can not apply a shear force to the barge, the horizontal (x) components of Fw and Fc must be equal. Therefore:

Fc_x = 89,780 lbs.

Fc_y = 80,840 lbs.

By estimating the amount of water used to ballast the YC, based upon POSSE and TPI tables, the value for Fb was determined to be about 120 to 130 tons more than in the ballasted condition. Not all of this lift force was applied to WENDY, wire stretch, anchor embedment and shifting of the equipment on the YC all occurred and each reduced the total effect on WENDY. However, additional lift and pull were applied to WENDY over that which was afforded by the hydraulic pullers alone. Of course, once movement of WENDY was initiated, only the force of the hydraulic pullers was available to continue the effort.

To calculate the approximate force required to move WENDY, three forces were required to be overcome. The first is the friction force caused by the ground reaction. This force was estimated by POSSE using the model of the ship and a bottom coefficient which for soft silty mud was 0.3. The second force was the result of having to lift WENDY up the slope. The final force was the force required to plow through the mud with the stern. This force is usually accounted for in bottom reaction. However, the slope of the bottom was increasing slightly during the first 50-75 feet of pull and it was felt that accounting for it separately would be more reasonable. As such, equation (1) was used to estimate the force required to move WENDY.

$$F = R\mu \cos\theta + R\sin\theta + P \qquad (1)$$

Where: F = Force required to move WENDY
R = Ground reaction
μ = Bottom coefficient
P = Plow force estimate
θ = Angle of slope for the bottom

To determine the angle of slope for the bottom, the depth at the bow and stern and the length of the ship were determined. The slope was then calculated to be 5.6 degrees but was rounded up to 6 degrees for use in further calculations. Table F-1 shows some of the values calculated.

Table F-1. Freeing Force Calculations (Ltons).

Ground Reaction	Friction Force	Lift Force	Plow Force	Total Pull Force
200	59.7	20.9	10	90.6
300	89.5	31.4	10	130.9
400	119.3	41.8	10	171.1
500	149.2	52.3	10	211.5

The value of these calculations is not necessarily to say that the ship will move once a particular pulling force is achieved, but to gain a feel for whether or not the equipment you are using is capable of developing the required force. If not, then alternative solutions must be evaluated until a working solution is found.

APPENDIX G

PHASE I PRELIMINARY POSSE HULL MODEL OF WENDY

The enclosed figures present the POSSE model for WENDY generated from divers' measurements of the ship and the generic cargo ship hull form found in Principles of Naval Architecture[1].

This model was used only to develop a broad feel for the nature of the ship and to begin planning the salvage in general terms. The model also provided a focal point from which questions as to what additional information was required could be developed.

1. Principles of Naval Architecture, John P. Comstock, Society of Naval Architects and Marine Engineers, 1980, New York, NY.

BULK CARRIER -- WENDY (SINKING on UNK)
Rev. 0 (by: GAP)

OOC POSSE-SHIPD V1.00
01-31-1993

GENERAL & LIGHTSHIP DATA
WENDY

GENERAL DATA

Ship Name	WENDY	
Ship Class	BULK CARRIER	
Yard No.		

Units	2	(ft|L.Tons)
Length Precision	2	(.xx)
Weight Precision	1	(.x)
Long'l Ref.	3	(abt FP)
Order of Long'l Data	2	(F to A)

Length Overall	248.00	ft
Length B.P.	248.00	ft
Beam	35.75	ft
Depth	20.00	ft
Propeller Diameter	6.00	ft
Shaft Centerline (abv BL)	3.50	ft
Draft Reference	Baseline	
Summer Load Line	18.00	ft

LIGHTSHIP & CONSTANT

Lightship Weight:	600.0	LTons
KG:	12.00	ft
LCG:	124.00A	ft-FP
TCG:	0.00	ft
Constant Weight:	0.0	LTons
KG:	0.00	ft
LCG:	124.00A	ft-FP
TCG:	0.00	ft
FSmom:	0.0	ft-LTons

DRAFT MARK LOCATIONS

Fwd Marks:	25.00A	ft-FP
Midship Marks:	124.00A	ft-FP
Aft Marks:	210.00A	ft-FP

Figure G-1. General and Lightship Data - WENDY.

BULK CARRIER -- WENDY (SINKING on UNK) OOC POSSE-LOAD V1.00
Rev. 0 (by: GAP) 01-18-1993

TRIM & STABILITY SUMMARY

ITEM	WEIGHT LTons	KG ft-BL	LCG ft-FP	TCG ft-CL	FSmom ft-LTons
Light Ship	600.0	12.00	124.00A	0.00	
Constant	0.0	0.00	124.00A	0.00	0.0
Misc. Weight	0.0	0.00	124.00A	0.00	0.0
SW Ballast	0.0	0.00	124.00A	0.00	0.0
TOTALS	600.0	12.00	124.00A	0.00	0.0

STABILITY CALCULATION

KMt	19.11 ft
KG	12.00 ft
GMt	7.12 ft
FSc	0.00 ft
GMt Corrected	7.12 ft

TRIM CALCULATION

LCF Draft	5.32 ft
LCB (even keel)	117.01 ft-AFT
LCF	117.21 ft-AFT
MT1in	91 ft-LT/in
Trim	3.84 ft-AFT
Prop. Immersion	114 %
List	0.00 deg

DRAFTS

F.P.	3ft- 6.05in (1.068m)	Fwd Marks	3ft-10.70in (1.186m)
M.S.	5ft- 5.08in (1.653m)	M.S.Marks	5ft- 5.08in (1.653m)
A.P.	7ft- 4.11in (2.238m)	Aft Marks	6ft- 9.05in (2.059m)

STRENGTH CALCULATIONS

Shear Force at 214.2 LT
Bending Moment at 15,438.0 ft-LTons [HOG]

Figure G-2. Trim and Stability Summary.

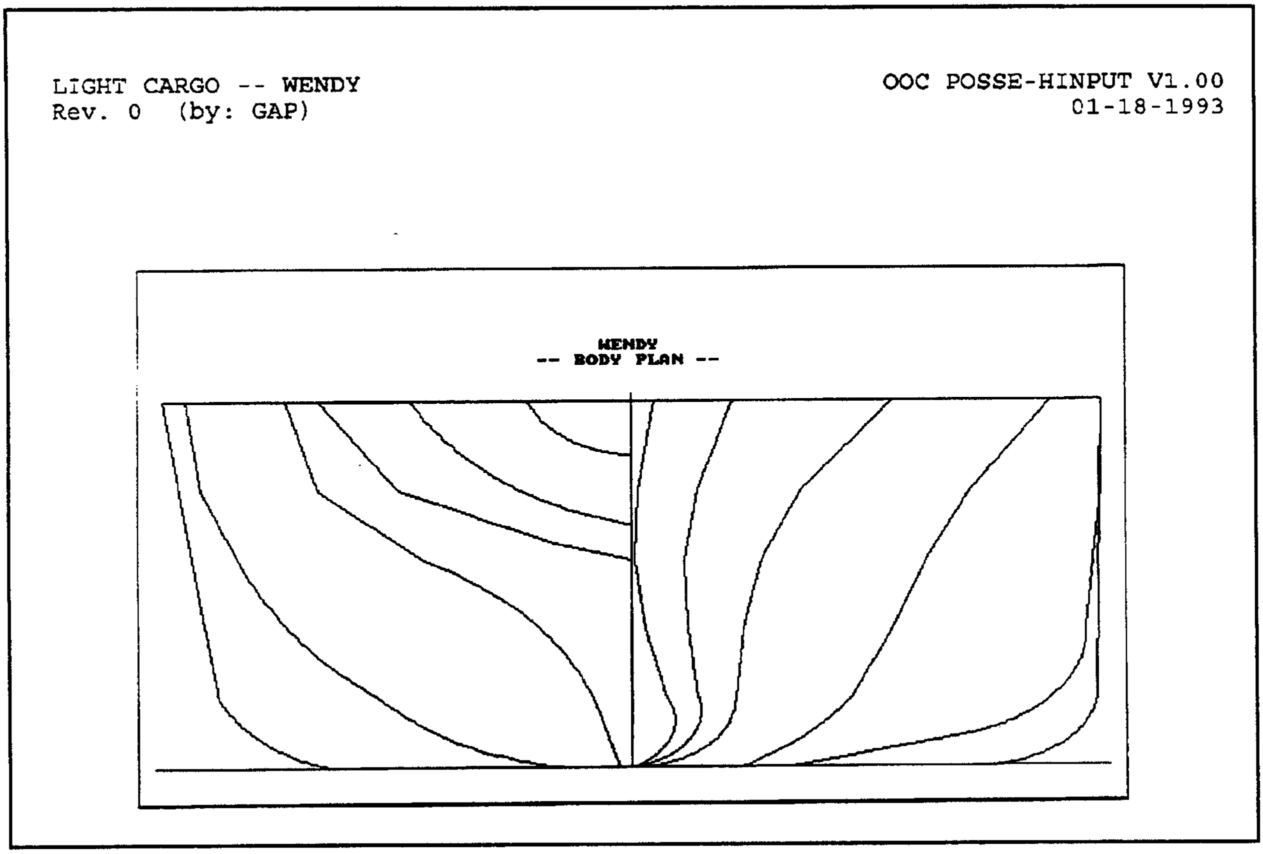

Figure G-3. WENDY Body Plan.

LIGHT CARGO -- WENDY
Rev. 0 (by: GAP)

OOC POSSE-HINPUT V1.00
01-18-1993

WENDY
HULL OFFSETS

General Information

Units = 2 (ft:L.Tons)
Long'l Ref. = 3 (F.P.)
Integ. Rule = 1 (Simpson's)

LBP = 248.000 ft
BEAM = 35.750 ft
DEPTH = 20.000 ft

Keel Thickness = 0.500 in

Appendage Allowance = 0.0050 x Displacement

Profile Offsets

	LOCATION ft-FP	HEIGHT ft		LOCATION ft-FP	HEIGHT ft		LOCATION ft-FP	HEIGHT ft		LOCATION ft-FP	HEIGHT ft
1	248.000A	18.000	3	225.000A	12.000	5	0.000	0.000	7	248.000A	21.161
2	240.000A	14.000	4	210.000A	0.000	6	0.000	21.161	8	248.000A	18.000

Plan Offsets

	LOCATION ft-FP	H-BRTH ft		LOCATION ft-FP	H-BRTH ft		LOCATION ft-FP	H-BRTH ft		LOCATION ft-FP	H-BRTH ft
1	248.000A	4.000S	7	90.000A	17.875S	13	15.000A	3.844P	19	210.000A	13.250P
2	240.000A	8.490S	8	60.000A	16.000S	14	30.000A	10.000P	20	225.000A	12.000P
3	225.000A	12.000S	9	30.000A	10.000S	15	60.000A	16.000P	21	240.000A	8.490P
4	210.000A	13.250S	10	15.000A	3.844S	16	90.000A	17.875P	22	248.000A	4.000P
5	180.000A	17.000S	11	0.000	1.521S	17	150.000A	17.875P	23	248.000A	4.000S
6	150.000A	17.875S	12	0.000	1.521P	18	180.000A	17.000P			

Figure G-4a. Wendy Hull Offsets (sheet 1 of 3).

LIGHT CARGO -- WENDY
Rev. 0 (by: GAP)

OOC POSSE-HINPUT V1.00
01-18-1993

WENDY
HULL OFFSETS

No. 1 (X= 0.000 ft-FP) [symmetrical]

	HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft
1	0.000	0.000C1	3	4.000	1.344	5	12.000	0.104	7	21.161	0.865C0
2	2.000	1.521*	4	8.000	0.500	6	16.000	0.208	8	21.161	0.000

No. 2 (X= 15.000A ft-FP) [symmetrical]

	HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft
1	0.000	0.000C1	3	4.000	2.531	5	12.000	2.031	7	21.161	3.844C0
2	2.000	2.365*	4	8.000	2.146	6	16.000	2.531	8	21.161	0.000

No. 3 (X= 30.000A ft-FP) [symmetrical]

	HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft
1	0.000	0.000C1	3	4.000	3.948	5	12.000	5.000	7	21.161	10.000C0
2	2.000	3.427*	4	8.000	4.250	6	16.000	6.500	8	21.161	0.000

No. 4 (X= 60.000A ft-FP) [symmetrical]

	HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft
1	0.000	0.000C1	4	4.000	8.396	7	16.000	13.000
2	0.000	4.167	5	8.000	10.000	8	21.161	16.000C0
3	2.000	6.823*	6	12.000	11.300	9	21.161	0.000

No. 5 (X= 90.000A ft-FP) [symmetrical]

	HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft
1	0.000	0.000C1	4	4.000	16.000*	7	16.000	17.875
2	0.000	6.083	5	8.000	17.300	8	21.161	17.875C0
3	2.000	13.300	6	12.000	17.600	9	21.161	0.000

No. 6 (X= 120.000A ft-FP) [symmetrical]

	HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft
1	0.000	0.000C1	3	1.296	16.421*	5	21.161	17.875C0
2	0.000	13.287	4	4.429	17.717	6	21.161	0.000

No. 7 (X= 150.000A ft-FP) [symmetrical]

	HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft
1	0.000	0.000C1	3	1.297	13.780*	5	21.161	17.875C0
2	0.000	11.483	4	4.000	15.748	6	21.161	0.000

No. 8 (X= 180.000A ft-FP) [symmetrical]

	HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft
1	0.000	0.000C1	4	4.000	9.635	7	16.000	16.417
2	0.000	2.240	5	8.000	13.083*	8	21.161	17.000C0
3	2.000	7.510*	6	12.000	15.000	9	21.161	0.000

Figure G-4b. Wendy Hull Offsets (sheet 2 of 3).

LIGHT CARGO -- WENDY
Rev. 0 (by: GAP)

OOC POSSE-HINPUT V1.00
01-18-1993

WENDY
HULL OFFSETS

	HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft
No. 9	**(X= 210.000A ft-FP)**			**[symmetrical]**							
1	0.000	0.000C1	4	4.000	1.500	7	16.000	12.000			
2	0.000	0.500	5	8.000	3.500*	8	21.161	13.250C0			
3	2.000	1.000	6	12.000	8.000	9	21.161	0.000			
No. 10	**(X= 225.000A ft-FP)**			**[symmetrical]**							
1	12.000	0.000C1	3	16.000	8.917	5	21.161	0.000			
2	13.000	3.000	4	21.161	12.000C0						
No. 11	**(X= 240.000A ft-FP)**			**[symmetrical]**							
1	14.000	0.000C1	2	16.000	4.260*	3	21.161	8.490C0	4	21.161	0.000
No. 12	**(X= 248.000A ft-FP)**			**[symmetrical]**							
1	18.000	0.000C1	2	19.000	2.500*	3	21.161	4.000C0	4	21.161	0.000

Figure G-4c. Wendy Hull Offsets (sheet 3 of 3).

APPENDIX H

PHASE I FINAL POSSE HULL MODEL OF WENDY

The enclosed figures present the POSSE model for WENDY generated from divers' measurements of the ship and damage control plans provided by the Honduran Government. The model presented here uses the 800 Lton lightship weight. This was not the original value used. To determine the lightship weight initially, the hull characteristics provided by the DETAILED analysis mode of POSSE were fed back into the RAPID analysis mode. The maximum value obtained for a bulk carrier (400 Ltons) was used during the development of the salvage plan. Although this represented a sizeable error, the salvage plan was still achievable although it required additional effort.

This model was used to develop an in depth salvage plan and was the basis for all on scene "what if " calculations. After the correction was made to the lightship weight, the model proved to be very accurate. Because of the initial discrepancy with the lightship weight, the information provided by POSSE was slow to be accepted by the salvage team. Only during the final week to ten days was the information provided by POSSE looked upon as being an accurate prediction of what was actually occurring.

FREIGHTER -- WENDY
Rev. 0 (by: GAP)

OOC POSSE-HINPUT V1.00
02-24-1993

WENDY
HULL OFFSETS

General Information

```
Units         =   2   (ft:L.Tons)
Long'l Ref. =   2   (A.P.)
Integ. Rule =   1   (Simpson's)

LBP   =  214.050 ft
BEAM  =   35.450 ft
DEPTH =   22.160 ft

Keel Thickness       =  0.500 in

Appendage Allowance = 0.0050 x Displacement
```

Profile Offsets

	LOCATION ft-AP	HEIGHT ft		LOCATION ft-AP	HEIGHT ft		LOCATION ft-AP	HEIGHT ft		LOCATION ft-AP	HEIGHT ft
1	8.335A	15.154	7	220.481F	24.000	13	197.000F	31.217	19	137.900F	22.125
2	0.000	10.244	8	225.406F	32.300	14	187.160F	30.793	20	59.100F	22.125
3	5.637F	0.000	9	225.406F	32.353	15	187.150F	22.852	21	39.400F	23.110
4	197.000F	0.000	10	220.481F	32.126	16	177.300F	22.670	22	8.335A	23.110
5	206.850F	2.467	11	214.041F	31.914	17	167.450F	22.428	23	8.335A	15.154
6	214.041F	12.669	12	206.850F	31.520	18	157.600F	22.337			

Plan Offsets

	LOCATION ft-AP	H-BRTH ft		LOCATION ft-AP	H-BRTH ft		LOCATION ft-AP	H-BRTH ft		LOCATION ft-AP	H-BRTH ft
1	8.335A	2.425S	10	177.300F	13.820S	19	220.481F	3.031P	28	137.900F	17.700P
2	0.000	7.941S	11	187.150F	11.517S	20	214.041F	6.456P	29	39.400F	17.700P
3	5.637F	10.790S	12	187.160F	16.245S	21	206.850F	10.123P	30	19.700F	15.639P
4	11.744F	13.154S	13	197.000F	13.548S	22	197.000F	13.548P	31	11.744F	13.154P
5	19.700F	15.639S	14	206.850F	10.123S	23	187.160F	16.245P	32	5.637F	10.790P
6	39.400F	17.700S	15	214.041F	6.456S	24	187.150F	11.517P	33	0.000	7.941P
7	137.900F	17.700S	16	220.481F	3.031S	25	177.300F	13.820P	34	8.335A	2.425P
8	157.600F	16.790S	17	225.406F	0.100S	26	167.450F	15.881P	35	8.335A	2.425P
9	167.450F	15.881S	18	225.406F	0.100P	27	157.600F	16.790P			

Figure H-1. WENDY Hull Offsets.

FREIGHTER -- WENDY
Rev. 0 (by: GAP)

OOC POSSE-SHIPD V1.00
02-24-1993

GENERAL & LIGHTSHIP DATA
WENDY

GENERAL DATA

Ship Name	WENDY
Ship Class	FREIGHTER
Yard No.	

Units	2	(ft|L.Tons)
Length Precision	3	(.xxx)
Weight Precision	1	(.x)
Long'l Ref.	2	(abt AP)
Order of Long'l Data	1	(A to F)

Length Overall	248.000 ft
Length B.P.	214.050 ft
Beam	35.450 ft
Depth	22.160 ft
Propeller Diameter	6.000 ft
Shaft Centerline (abv BL)	4.122 ft
Draft Reference	Baseline
Summer Load Line	20.000 ft

LIGHTSHIP & CONSTANT

Lightship Weight:	800.0	LTons
KG:	13.000	ft
LCG:	80.000F	ft-AP
TCG:	0.000	ft
Constant Weight:	0.0	LTons
KG:	0.000	ft
LCG:	107.025F	ft-AP
TCG:	0.000	ft
FSmom:	0.0	ft-LTons

DRAFT MARK LOCATIONS

Aft Marks:	0.000	ft-AP
Midship Marks:	107.025F	ft-AP
Fwd Marks:	214.000F	ft-AP

Figure H-2. Overall and Lightship Data - WENDY.

```
FREIGHTER -- WENDY  (SINKING on 1989)                       OOC POSSE-LOAD V1.00
Rev. 0  (by: GAP)                                                     02-24-1993

                         TRIM & STABILITY SUMMARY


                        WEIGHT       KG       LCG       TCG         FSmom
       ITEM              LTons     ft-BL     ft-AP     ft-CL      ft-LTons
      -------------------------------------------------------------------
       Light Ship        800.0    13.000   80.000F    0.000
       Constant            5.6     2.986    8.624F    0.000          1.5

       Bulk Cargo        100.0    13.000  120.000F    0.000
       Misc. Weight        0.0     0.000  107.025F    0.000          0.0

       Diesel Oil         17.6     3.764  113.152F    0.000        291.3
       Fresh Water        13.1     1.944   92.533F    0.000         35.0
       SW Ballast        336.7     2.317  117.113F    0.000        447.5
      -------------------------------------------------------------------
       TOTALS          1,273.0     9.889   93.229F    0.000        775.2


       STABILITY CALCULATION            TRIM CALCULATION
        KMt                14.928 ft      LCF Draft           9.216 ft
        KG                  9.889 ft      LCB (even keel)   107.05 ft-FWD
        GMt                 5.039 ft      LCF              102.900 ft-FWD
        FSc                 0.609 ft      MT1in                145 ft-LT/in
        GMt  Corrected      4.430 ft      Trim              10.078 ft-AFT
                                          Prop. Immersion      216 %
                                          List                0.00 deg


       DRAFTS
         A.P.  14ft- 0.73in ( 4.286m)       Aft Marks 14ft- 0.73in ( 4.286m)
         M.S.   9ft- 0.26in ( 2.750m)       M.S.Marks  9ft- 0.26in ( 2.750m)
         F.P.   3ft-11.79in ( 1.214m)       Fwd Marks  3ft-11.82in ( 1.215m)
```

Figure H-3. Trim and Stability Summary.

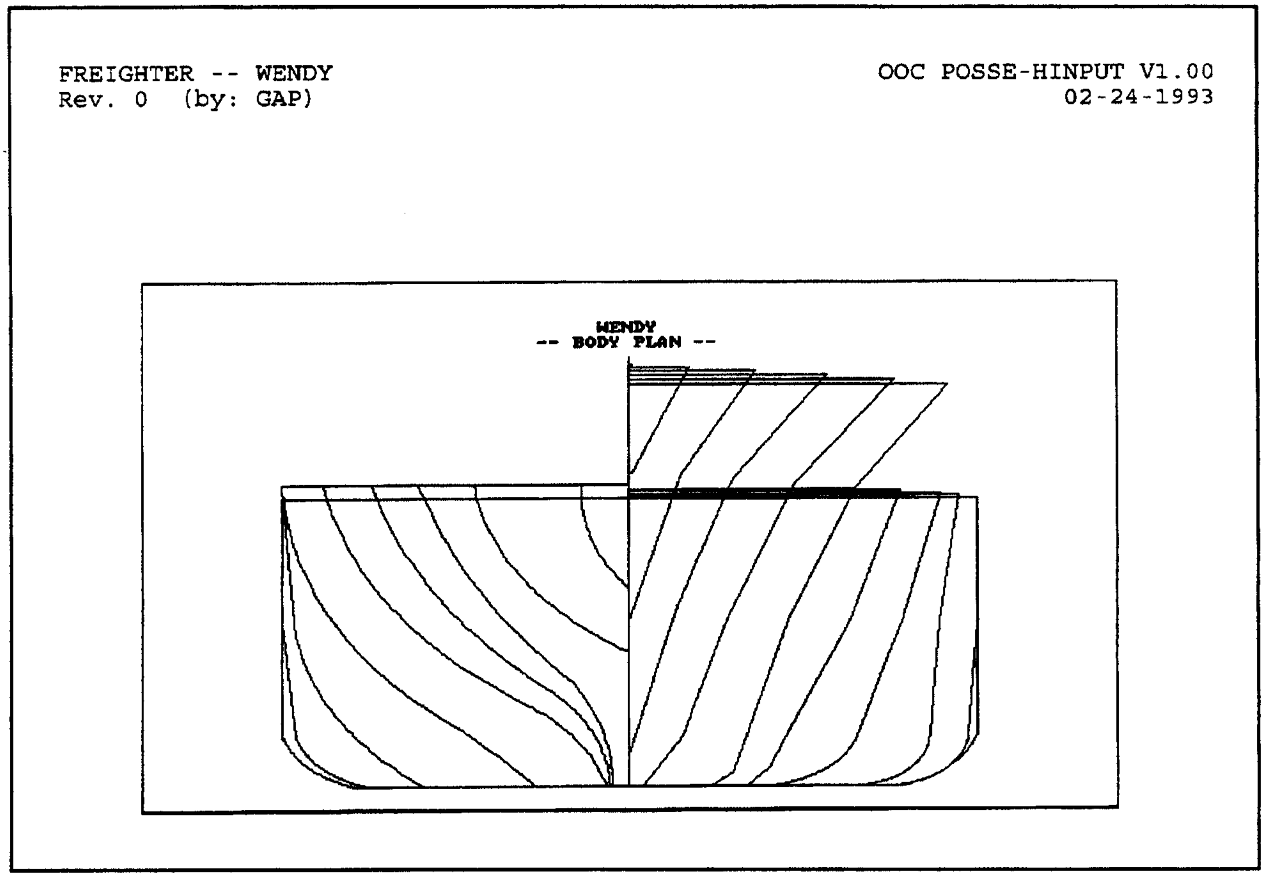

Figure H-4. Wendy Body Plan.

FREIGHTER -- WENDY
Rev. 0 (by: GAP)

OOC POSSE-HINPUT V1.00
02-24-1993

WENDY
HULL OFFSETS

	HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft
No. 1 (X= 8.335A ft-AP) [symmetrical]											
1	15.154	0.000C0	2	15.850	0.500*	3	23.110	2.425C1	4	23.110	0.000
No. 2 (X= 0.000 ft-AP) [symmetrical]											
1	10.244	0.000C0	2	15.154	4.970*	3	23.110	7.941C1	4	23.110	0.000
No. 3 (X= 5.637F ft-AP) [symmetrical]											
1	0.000	0.000C0	3	3.800	1.300*	5	15.154	7.759*	7	23.110	0.000
2	0.000	0.900C2	4	8.000	3.000	6	23.110	10.790C1			
No. 4 (X= 11.744F ft-AP) [symmetrical]											
1	0.000	0.000C0	3	3.800	1.800*	5	15.154	10.153*	7	23.110	0.000
2	0.000	1.000C2	4	7.000	3.800	6	23.110	13.154C1			
No. 5 (X= 19.700F ft-AP) [symmetrical]											
1	0.000	0.000C0	3	3.888	3.000*	5	15.154	12.972*	7	23.110	0.000
2	0.000	1.200C2	4	6.000	5.000	6	23.110	15.639C1			
No. 6 (X= 39.400F ft-AP) [symmetrical]											
1	0.000	0.000C0	3	3.888	8.270*	5	14.320	15.881*	7	23.110	0.000
2	0.000	4.849C2	4	6.000	10.500	6	23.110	17.700C1			
No. 7 (X= 59.100F ft-AP) [symmetrical]											
1	0.000	0.000C0	3	3.888	14.059*	5	22.125	17.700C1			
2	0.000	10.486C2	4	12.547	17.094	6	22.125	0.000			
No. 8 (X= 78.800F ft-AP) [symmetrical]											
1	0.000	0.000C0	3	1.000	15.200*	5	12.547	17.700	7	22.125	0.000
2	0.000	13.275C2	4	3.888	17.029	6	22.125	17.700C1			

Figure H-5. Wendy Hull Offsets (sheet 1 of 3).

FREIGHTER -- WENDY
Rev. 0 (by: GAP)

OOC POSSE-HINPUT V1.00
02-24-1993

WENDY
HULL OFFSETS

	HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft
No. 9 (X= 98.500F ft-AP) [symmetrical]											
1	0.000	0.000C0	3	1.000	15.800*	5	12.547	17.700	7	22.125	0.000
2	0.000	13.942C2	4	3.888	17.700	6	22.125	17.700C1			
No. 10 (X= 118.200F ft-AP) [symmetrical]											
1	0.000	0.000C0	3	1.000	15.800*	5	12.547	17.700	7	22.125	0.000
2	0.000	13.942C2	4	3.888	17.700	6	22.125	17.700C1			
No. 11 (X= 137.900F ft-AP) [symmetrical]											
1	0.000	0.000C0	3	1.000	15.800*	5	12.547	17.700	7	22.125	0.000
2	0.000	13.457C2	4	3.888	17.272	6	22.125	17.700C1			
No. 12 (X= 157.600F ft-AP) [symmetrical]											
1	0.000	0.000C0	3	1.000	14.000*	5	12.547	15.760	7	22.337	0.000
2	0.000	11.171C2	4	3.688	15.272	6	22.337	16.790C1			
No. 13 (X= 167.450F ft-AP) [symmetrical]											
1	0.000	0.000C0	3	1.000	9.698*	5	12.608	13.942	7	22.428	0.000
2	0.000	6.062C2	4	3.888	11.699	6	22.428	15.881C1			
No. 14 (X= 177.300F ft-AP) [symmetrical]											
1	0.000	0.000C0	3	1.400	7.200	5	22.670	13.820C1			
2	0.000	6.000C2	4	12.547	11.274	6	22.670	0.000			
No. 15 (X= 187.150F ft-AP) [symmetrical]											
1	0.000	0.000C0	3	1.000	5.334	5	22.852	11.517C1			
2	0.000	4.243C2	4	12.638	8.153	6	22.852	0.000			
No. 16 (X= 187.160F ft-AP) [symmetrical]											
1	0.000	0.000C0	3	1.000	5.334	5	22.852	11.517	7	30.793	0.000
2	0.000	4.243C2	4	12.638	8.153	6	30.793	16.245C1			

Figure H-5. Wendy Hull Offsets (sheet 2 of 3).

FREIGHTER -- WENDY
Rev. 0 (by: GAP)

OOC POSSE-HINPUT V1.00
02-24-1993

WENDY
HULL OFFSETS

	HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft
No. 17 (X= 197.000F ft-AP) [symmetrical]											
1	0.000	0.000C0	3	3.889	2.788	5	23.228	8.486	7	31.217	0.000
2	0.000	0.667C2	4	12.729	4.970	6	31.217	13.548C1			
No. 18 (X= 206.850F ft-AP) [symmetrical]											
1	2.467	0.000C0	3	23.640	5.334	5	31.520	0.000			
2	13.760	2.406	4	31.520	10.123C1						
No. 19 (X= 214.041F ft-AP) [symmetrical]											
1	12.669	0.000C0	2	23.901	2.606	3	31.914	6.456C1	4	31.914	0.000
No. 20 (X= 220.481F ft-AP) [symmetrical]											
1	24.000	0.000C0	2	24.057	0.100	3	32.126	3.031C1	4	32.126	0.000
No. 21 (X= 225.406F ft-AP) [symmetrical]											
1	32.300	0.000C0	2	32.353	0.100C1	3	32.353	0.000			

Figure H-5. Wendy Hull Offsets (sheet 3 of 3).

FREIGHTER -- WENDY (SINKING on 1989) OOC POSSE-LOAD V1.00
Rev. 0 (by: GAP) 02-24-1993

TANK WEIGHT SUMMARY

Diesel Oil Tanks

TANK NAME	WEIGHT LTons	% Full	CAPACITY LTons	VOLUME bbls	NET VOL. bbls	API GRAV.	TEMP. oF	SP.VOL. bbls/LT	KG ft-BL	LCG ft AP	TCG ft CL	F.S ft-LTons
TANK3P	6.5	26.7	24.3	45.2	45.2	----	60.0	6.9465	2.037	135.861F	11.337P	74.9
TANK3S	6.5	26.7	24.3	45.2	45.2	----	60.0	6.9465	2.037	135.861F	11.337S	74.9
TANK4P	0.8	5.0	15.9	5.5	5.5	----	60.0	6.9465	2.048	116.157F	11.330P	51.4
TANK4S	0.8	5.0	15.9	5.5	5.5	----	60.0	6.9465	2.048	116.157F	11.330S	51.4
SETTLING	3.0	50.0	6.0	20.8	20.8	----	60.0	6.9465	12.190	12.822F	0.000	36.6
TOTALS	17.6	20.3	86.4	122.1	122.1				3.764	113.152F	0.000	291.3

Fresh Water Tanks

TANK NAME	WEIGHT LTons	% Full	CAPACITY LTons	VOLUME ft3	SP.VOL. ft3/LT	KG ft-BL	LCG ft-AP	TCG ft-CL	F.S. ft-LTons
TANK5C	13.1	50.0	26.2	470.6	35.8814	1.944	92.533F	0.000	35.0
TOTALS	13.1	50.0	26.2	470.6		1.944	92.533F	0.000	35.0

SW Ballast Tanks

TANK NAME	WEIGHT LTons	% Full	CAPACITY LTons	VOLUME ft3	SP.VOL. ft3/LT	KG ft-BL	LCG ft-AP	TCG ft-CL	F.S. ft-LTons
STEERING	0.0	0.0	63.5	0.0	35.0062	19.408	4.011F	0.000	0.0
AFTER PEAK	0.0	0.0	30.1	0.0	35.0062	11.589	6.641F	0.000	0.0
AFT HOLD	0.0	0.0	68.0	0.0	35.0062	19.321	11.432F	1.483S	0.0
MISC 1C	0.0	0.0	15.9	0.0	35.0062	19.132	18.715F	1.061S	0.0
ENGINE RM	0.0	0.0	353.0	0.0	35.0062	13.228	31.553F	0.600S	0.0
MISC 2P	0.0	0.0	28.9	0.0	35.0062	18.829	39.622F	12.071P	0.0
FORECASTLE	0.0	0.0	122.5	0.0	35.0062	27.822	200.248F	0.000	0.0
UPPER PEAK	0.0	0.0	35.5	0.0	35.0062	19.570	206.052F	0.004P	0.0
LOWER PEAK	13.8	100.0	13.8	482.4	35.0062	9.257	203.504F	0.000	5.8
TANK1	40.6	100.0	40.6	1,422.6	35.0062	2.071	179.473F	0.000	67.4
TANK2 PORT	30.2	100.0	30.2	1,057.2	35.0062	2.011	156.880F	7.188P	45.6
TANK2 STBD	30.2	100.0	30.2	1,057.2	35.0062	2.011	156.880F	7.188S	45.6
TANK3C	52.0	100.0	52.0	1,820.1	35.0062	1.944	128.050F	0.000	54.9
TANK5P	42.5	100.0	42.5	1,486.4	35.0062	2.033	92.718F	10.114P	51.6
TANK5S	42.5	100.0	42.5	1,486.4	35.0062	2.033	92.718F	10.114S	51.6
TANK6P	42.5	100.0	42.5	1,486.7	35.0062	2.037	62.677F	6.483P	62.5
TANK6S	42.5	100.0	42.5	1,486.7	35.0062	2.037	62.677F	6.483S	62.5
CARGO	0.0	0.0	2,458.6	0.0	35.0062	13.280	115.784F	0.000	0.0
TOTALS	336.7	9.6	3,512.8	11,785.6		2.317	117.113F	0.000	447.5

Figure H-6. Tank Weight Summary (sheet 1 of 2).

FREIGHTER -- WENDY (SINKING on 1989)   OOC POSSE-LOAD V1.00
Rev. 0 (by: GAP)   02-24-1993

TANK WEIGHT SUMMARY

Constant

ITEM	WEIGHT LTons	KG ft-BL	LCG ft-AP	TCG ft-CL	F.S. ft-LTons
CEMENT SHAFT	5.6	2.986	8.624F	0.000	1.5
TOTALS	5.6	2.986	8.624F	0.000	1.5

Figure H-6. Tank Weight Summary (sheet 2 of 2).

FREIGHTER -- WENDY (SINKING on 1989)   OOC POSSE-LOAD V1.00
Rev. 0 (by: GAP)   02-24-1993

CARGO SUMMARY

BulkIn Hold

	WEIGHT LTons	VCG ft-BL	LCG ft-AP	TCG ft-CL	VOLUME ft3	S.F. ft3/LT
PAPER	100.0	13.000	120.000F	0.000	9,999.0	99.9900
Totals	100.0	13.000	120.000F	0.000	9,999.0	99.9900

Figure H-7. Cargo Summary.

APPENDIX I

PHASE III INITIAL PULL OF WENDY

The enclosed figures present the POSSE model for the configuration of WENDY as she was at the time of the initial pull into shallower water.

The engine room was estimated to be 30 to 35 percent full of water at the time she actually began to move. This would have added another 35 to 45 tons of friction force to the estimated 88 tons calculated here. In addition, as shown in Appendix F, an additional 35 to 40 tons was required to overcome the lifting of WENDY up the slope. This total of 160 Ltons is fairly close to the estimated 140 Ltons of pull generated by the three hydraulic pullers plus the added force provided by de-ballasting of the YC. The Aft Hold and Steering compartments were estimated to be empty.

FREIGHTER -- WENDY (SINKING on 1989)
Rev. 0 (by: GAP)

OOC POSSE-SALV V1.00
02-24-1993

STRANDING on SHELF
AFTDW800

Damaged Compartments:

UPPER PEAK	FORECASTLE	LOWER PEAK	CARGO	TANK1	TANK2 STBD
TANK2 PORT	TANK3C	TANK4S	TANK4P	TANK5C	MISC 2P
MISC 1C	AFTER PEAK				

	DISPLACEMENT LTons	DRAFT AFT ft	DRAFT FWD ft	TRIM ft	HEEL deg.	UPRIGHT GMt ft
INTACT	1,273.0	14.061	3.983	10.078A	0.00	4.430
STRANDED	4,012.2	44.377	63.679	19.302F	0.00	-4.212

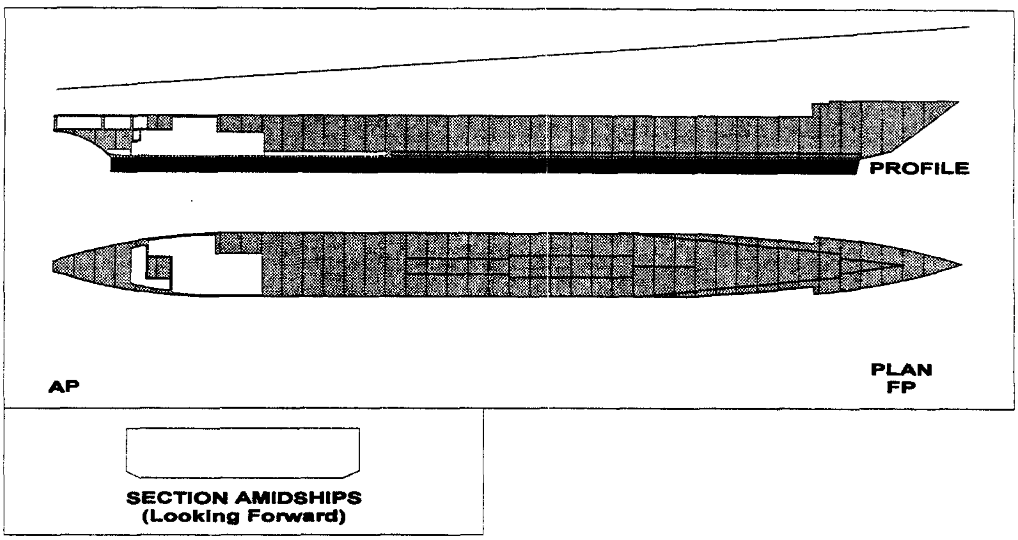

Figure I-1. Stranding on Shelf AFTDW800 (sheet 1 of 2)

FREIGHTER -- WENDY (SINKING on 1989) OOC POSSE-SALV V1.00
Rev. 0 (by: GAP) 02-24-1993

STRANDING on SHELF
AFTDW800

OBSERVED DATA

Draft at A.P.	---	
Draft at F.P.	---	
Static Heel Angle	0.000	deg
Tidal Height	0.000	ft

Specified Ground Contact	SHELF AFT		SHELF FWD	
Longitudinal Location	7.000F	ft-AP	198.000F	ft-AP
Transverse Location	0.000	ft-CL	0.000	ft-CL
Depth of Water Over Ground	45.000	ft	62.000	ft

COMPUTED DATA

Type of Ground Contact	ON SHELF	
(R) Ground Reaction	260.8	LTons
(LCR) Long'l Ctr. of Grd. Reaction	180.210F	ft-AP
Water Depth at LCR	60.627	ft
Ht of Contact Pt. abv. Baseline	0.000	ft
Aft Boundary of Ground Contact	144.631F	ft-AP
Fwd Boundary of Ground Contact	198.000F	ft-AP
(TCR) Transv. Ctr. of Grd. Reaction	1.274P	ft-CL
Long'l Extent of Ground Contact	53.369	ft
Transv. Extent of Ground Contact	1.000	ft
Grounding Contact Area	53.369	ft2
Pressure on Hull	4.887	LT/ft

Neutral Load Point	---	
LBP	214.050	ft
LCF	5.637F	ft-AP
Mt1in	-0.0	ft-LT/in
TPI	0.00	LT/in
(F) Force to Free	87.6	ST
Coef. of Friction	0.30	
Seafloor Type	SILT	

Figure I-2. Stranding on Shelf AFTDW800 (sheet 2 of 2).

FREIGHTER -- WENDY (SINKING on 1989) OOC POSSE-SALV V1.00
Rev. 0 (by: GAP) 02-24-1993

STRANDED CONDITION
AFTDW800

ITEM	WEIGHT LTons	KG ft-BL	LCG ft-AP	TCG ft-CL	FSmom ft-LTons
Light Ship	800.0	13.000	80.000F	0.000	
Constant	5.6	2.986	8.624F	0.000	1.5
Bulk Cargo	100.0	13.000	120.000F	0.000	
Misc. Weight	0.0	0.000	107.025F	0.000	0.0
Diesel Oil	17.6	3.764	113.152F	0.000	291.3
Fresh Water	13.1	1.944	92.533F	0.000	35.0
SW Ballast	336.7	2.317	117.113F	0.000	447.5
TOTALS	1,273.0	9.889	93.229F	0.000	775.2

		INTACT	AFTER OUTFLOW	AS STRANDED
Draft at A.P.	(ft)	14.061	----	44.377
Draft at F.P.	(ft)	3.983	----	63.679
Trim	(ft)	10.078A	----	19.302F
Draft at Aft Marks	(ft)	14.061	----	44.377
Draft at Fwd Marks	(ft)	3.985	----	63.674
Static Heel Angle	(deg)	0.00	----	0.00
Total Weight	(LT)	1,273.0	1,091.5	4,012.2
KG	(ft)	9.889	11.109	12.621
LCG	(ft-AP)	93.229F	83.420F	110.179F
TCG	(ft-CL)	0.000	0.000	0.083P
Buoyancy	(LT)	1,273.0	----	3,751.4
KB	(ft)	----	----	12.677
LCB	(ft-AP)	107.048F	----	105.384F
TCB	(ft-CL)	----	----	0.000
KMt	(ft)	14.928	----	10.889
FSc	(ft)	0.609	----	0.503
GMt	(ft)	4.430	----	-4.212
Shear Force	(LT)	----	----	----
Bending Moment	(ft-LT)	----	----	----

AFTER OUTFLOW CONDITION:
Displacement, KG, LCG, TCG include the effects of fluid outflow & flooding without free-communication.
AS STRANDED CONDITION:
Displacement, KG, LCG, TCG include the effects of the flooded water at the equilibrium trim/heel.
Buoyancy, KB, LCB, TCB are for an intact hull at the equilibrium heel and drafts.
KMt is for the damaged hull at the upright flooded drafts.
F.S. correction accounts for the free surface of intact tanks and is corrected for outflow.

Figure I-3. Stranded Condition AFTDW800.

FREIGHTER -- WENDY (SINKING on 1989)
Rev. 0 (by: GAP)

OOC POSSE-SALV V1.00
02-24-1993

TANK WEIGHT SUMMARY

Diesel Oil Tanks

TANK NAME	WEIGHT LTons	% Full	CAPACITY LTons	VOLUME bbls	NET VOL. bbls	API GRAV.	TEMP. oF	SP.VOL. bbls/LT	KG ft-BL	LCG ft-AP	TCG ft-CL	F.S. ft-LTons
TANK3P	6.5	26.7	24.3	45.2	45.2	----	60.0	6.9465	2.037	135.861F	11.337P	74.9
TANK3S	6.5	26.7	24.3	45.2	45.2	----	60.0	6.9465	2.037	135.861F	11.337S	74.9
TANK4P	0.8	5.0	15.9	5.5	5.5	----	60.0	6.9465	2.048	116.157F	11.330P	51.4
TANK4S	0.8	5.0	15.9	5.5	5.5	----	60.0	6.9465	2.048	116.157F	11.330S	51.4
SETTLING	3.0	50.0	6.0	20.8	20.8	----	60.0	6.9465	12.190	12.822F	0.000	38.6
TOTALS	17.6	20.3	86.4	122.1	122.1				3.764	113.152F	0.000	291.3

Fresh Water Tanks

TANK NAME	WEIGHT LTons	% Full	CAPACITY LTons	VOLUME ft3	SP.VOL. ft3/LT	KG ft-BL	LCG ft-AP	TCG ft-CL	F.S. ft-LTons
TANK5C	13.1	50.0	26.2	470.6	35.8814	1.944	92.533F	0.000	35.0
TOTALS	13.1	50.0	26.2	470.6		1.944	92.533F	0.000	35.0

SW Ballast Tanks

TANK NAME	WEIGHT LTons	% Full	CAPACITY LTons	VOLUME ft3	SP.VOL. ft3/LT	KG ft-BL	LCG ft-AP	TCG ft-CL	F.S. ft-LTons
STEERING	0.0	0.0	63.5	0.0	35.0062	19.408	4.011F	0.000	0.0
AFTER PEAK	0.0	0.0	30.1	0.0	35.0062	11.589	6.641F	0.000	0.0
AFT HOLD	0.0	0.0	68.0	0.0	35.0062	19.321	11.432F	1.483S	0.0
MISC 1C	0.0	0.0	15.9	0.0	35.0062	19.132	18.715F	1.061S	0.0
ENGINE RM	0.0	0.0	353.0	0.0	35.0062	13.228	31.553F	0.600S	0.0
MISC 2P	0.0	0.0	28.9	0.0	35.0062	18.829	39.622F	12.071P	0.0
FORECASTLE	0.0	0.0	122.5	0.0	35.0062	27.822	200.248F	0.000	0.0
UPPER PEAK	0.0	0.0	35.5	0.0	35.0062	19.570	206.052F	0.004P	0.0
LOWER PEAK	13.8	100.0	13.9	482.4	35.0062	9.257	203.504F	0.000	5.8
TANK1	40.6	100.0	40.6	1,422.6	35.0062	2.071	179.473F	0.000	67.4
TANK2 PORT	30.2	100.0	30.2	1,057.2	35.0062	2.011	156.880F	7.188P	45.6
TANK2 STBD	30.2	100.0	30.2	1,057.2	35.0062	2.011	156.880F	7.188S	45.6
TANK3C	52.0	100.0	52.0	1,820.1	35.0062	1.944	128.050F	0.000	54.9
TANK5P	42.5	100.0	42.5	1,486.4	35.0062	2.033	92.718F	10.114P	51.6
TANK5S	42.5	100.0	42.5	1,486.4	35.0062	2.033	92.718F	10.114S	51.6
TANK6P	42.5	100.0	42.5	1,486.7	35.0062	2.037	62.677F	6.483P	62.5
TANK6S	42.5	100.0	42.5	1,486.7	35.0062	2.037	62.677F	6.483S	62.5
CARGO	0.0	0.0	2,458.6	0.0	35.0062	13.280	115.784F	0.000	0.0
TOTALS	336.7	9.6	3,512.8	11,785.6		2.317	117.113F	0.000	417.5

Figure I-4. Tank Weight Summary.

FREIGHTER -- WENDY (SINKING on 1989) OOC POSSE-SALV V1.00
Rev. 0 (by: GAP) 02-24-1993

TANK WEIGHT SUMMARY

Constant

ITEM	WEIGHT LTons	KG ft-BL	LCG ft-AP	TCG ft-CL	F.S. ft-LTons
CEMENT SHAFT	5.6	2.986	8.624F	0.000	1.5
TOTALS	5.6	2.986	8.624F	0.000	1.5

Figure I-5. Tank Weight Summary.

FREIGHTER -- WENDY (SINKING on 1989) OOC POSSE-SALV V1.00
Rev. 0 (by: GAP) 02-24-1993

CARGO SUMMARY

BulkIn Hold

	WEIGHT LTons	VCG ft-BL	LCG ft-AP	TCG ft-CL	VOLUME ft3	S.F. ft3/LT
PAPER	100.0	13.000	120.000F	0.000	9,999.0	99.9900
Totals	100.0	13.000	120.000F	0.000	9,999.0	99.9900

Firgure I-6. Cargo Summary.

FREIGHTER -- WENDY (SINKING on 1989) OOC POSSE-SALV V1.00
Rev. 0 (by: GAP) 02-24-1993

FLUID OUTFLOW AFTER DAMAGE
AFTDW800

COMPARTMENT	FLUID OUTFLOW LTons	SP.VOL. ft3/LT	-------INTACT DATA BEFORE OUTFLOW------- % FULL	KG ft	LCG ft-AP	TCG ft-CL	FSc ft	Data Source
UPPER PEAK	0.0	35.0063	0.0	0.000	107.025F	0.000	0.000	Load Case
FORECASTLE	0.0	35.0063	0.0	0.000	107.025F	0.000	0.000	Load Case
LOWER PEAK	13.8	35.0063	100.0	9.257	203.504F	0.000	0.005	Load Case
CARGO	0.0	35.0063	0.0	0.000	107.025F	0.000	0.000	Load Case
TANK1	40.6	35.0063	100.0	2.071	179.473F	0.000	0.053	Load Case
TANK2 STBD	30.2	35.0063	100.0	2.011	156.880F	7.188S	0.036	Load Case
TANK2 PORT	30.2	35.0063	100.0	2.011	156.880F	7.188P	0.036	Load Case
TANK3C	52.0	35.0063	100.0	1.944	128.050F	0.000	0.043	Load Case
TANK4S	0.8	39.0015	5.0	2.048	116.157F	11.330S	0.040	Load Case
TANK4P	0.8	39.0015	5.0	2.048	116.157F	11.330P	0.040	Load Case
TANK5C	13.1	35.8814	50.0	1.944	92.533F	0.000	0.027	Load Case
MISC 2P	0.0	35.0063	0.0	0.000	107.025F	0.000	0.000	Load Case
MISC 1C	0.0	35.0063	0.0	0.000	107.025F	0.000	0.000	Load Case
AFTER PEAK	0.0	35.0063	0.0	0.000	107.025F	0.000	0.000	Load Case
TOTALS	181.5						0.280	

Figure I-7. Fluid Outflow After Damage AFTDW800

FLOODING AFTER DAMAGE
(For Equilibrium at 0.0o Heel)

COMPARTMENT	SEAWATER LTons	OIL LTons	PERM.	SP.VOL. ft3/LT	KG ft	LCG ft-AP	TCG ft-CL	FSc ft	SOUNDING ft	SPECIFIED % Full	PRESSURE PsiG
UPPER PEAK	35.5	----	0.98	35.0063	19.570	206.052F	0.004P	0.000	[FREE]	---	---
FORECASTLE	122.5	----	0.98	35.0063	27.822	200.248F	0.000	0.000	[FREE]	---	---
LOWER PEAK	13.8	----	0.98	35.0063	9.257	203.504F	0.000	0.000	[FREE]	-	---
CARGO	2458.6	----	0.98	35.0063	13.280	115.784F	0.000	0.000	[FREE]	---	---
TANK1	40.6	----	0.99	35.0063	2.071	179.473F	0.000	0.000	[FREE]	---	---
TANK2 STBD	30.2	----	0.98	35.0063	2.011	156.880F	7.188S	0.000	[FREE]	---	---
TANK2 PORT	30.2	----	0.98	35.0063	2.011	156.880F	7.188P	0.000	[FREE]	---	---
TANK3C	52.0	----	0.98	35.0063	1.944	128.050F	0.000	0.000	[FREE]	---	---
TANK4S	17.7	----	0.98	35.0063	2.048	116.157F	11.330S	0.000	[FREE]	---	---
TANK4P	17.7	----	0.98	35.0063	2.048	116.157F	11.330P	0.000	[FREE]	---	---
TANK5C	26.9	----	0.98	35.0063	1.944	92.533F	0.000	0.000	[FREE]	---	---
MISC 2P	28.9	----	0.96	35.0063	18.829	39.622F	12.071P	0.000	[FREE]	---	
MISC 1C	15.9	----	0.98	35.0063	19.132	18.715F	1.061S	0.000	[FREE]	---	---
AFTER PEAK	30.[illegible]	----	0.98	35.0063	11.589	6.641F	0.000	0.000	[FREE]	---	
TOTALS	2920.7	0.0			13.185	120.179F	0.114P	0.000			

Figure I-8. Flooding After Damage (For Equilibrium at 0.0o Heel).

FREIGHTER -- WENDY (SINKING on 1989)
Rev. 0 (by: GAP)

OOC POSSE-SALV V1.00
02-24-1993

DAMAGE EVALUATION SUMMARY
AFTDW800

Stranding Evaluation: (STRANDING on SHELF)
Total Ground Reaction = 260.8 LTons   Force to Free = 87.6 STons
Longl Center of Grd.R.= 180.210F ft-AP   Bottom Type = Silt (Cf=0.30)

Summary of Breached Compartments:

BREACHED COMPARTMENTS	PERM.	FLOODED WATER LTons	% FULL (Intact)	SP.VOL. ft3/LT	OUTFLOW LTons
UPPER PEAK	0.980	35.5	0.0	----	----
FORECASTLE	0.980	122.5	0.0	----	----
LOWER PEAK	0.980	13.8	100.0	35.0063	13.8
CARGO	0.980	2,458.6	0.0	----	----
TANK1	0.990	40.6	100.0	35.0063	40.6
TANK2 STBD	0.980	30.2	100.0	35.0063	30.2
TANK2 PORT	0.980	30.2	100.0	35.0063	30.2
TANK3C	0.980	52.0	100.0	35.0063	52.0
TANK4S	0.980	17.7	5.0	39.0015	0.8
TANK4P	0.980	17.7	5.0	39.0015	0.8
TANK5C	0.980	26.9	50.0	35.8814	13.1
MISC 2P	0.980	28.9	0.0	----	----
MISC 1C	0.980	15.9	0.0	----	---
AFTER PEAK	0.980	30.1	0.0	----	----
TOTALS		2,920.7			181.5

OIL OUTFLOW = 1.6 LTons

Figure I-9. Damage Evaluation Summary AFTDW800.

FREIGHTER -- WENDY (SINKING on 1989)
Rev. 0 (by: GAP)

OOC POSSE-SALV V1.00
02-24-1993

SALVAGE COMPARISON TABLE

		Intact#1	Damage#1
Calculation Basis		HYDRO	OFFSETS
Case Name		----	AFTDW800
Draft Aft	(ft)	14.061	44.377
Draft Fwd	(ft)	3.983	63.679
Trim	(ft)	10.078A	19.302F
Total Weight	(LT)	1,273.0	4,012.2
Static Heel	(deg)	0.00	0.00
WindHeel	(deg)	----	----
GMt (upright)	(ft)	4.430	-4.212
Maximum GZ	(ft)	----	----
Max.GZ Angle	(deg)	0.00	0.00
GZ Pos.Range	(deg)	----	----
Outflow	(LT)	----	181.5
Flooded Water	(LT)	----	2,920.7
Shear Force	(LT)	----	----
B.Moment	(ft-LT)	----	----
Stranding Type		----	ON SHELF
Tidal Height	(ft)	----	0.000
Grd.Reaction	(LT)	----	260.8
L.C.R.	(ft-AP)	----	180.210F
T.C.R.	(ft)	----	1.274P
Grd.React.#1	(LT)	----	260.8
L.C.R.1	(ft-AP)	----	180.210F
Aft Bnd.	(ft-AP)	----	144.631F
Fwd Bnd.	(ft-AP)	----	198.000F
Water Depth	(ft)	----	60.627
Grd.React.#2	(LT)	----	----
L.C.R.2	(ft-AP)	----	----
Aft Bnd.	(ft-AP)	----	----
Fwd Bnd.	(ft-AP)	----	----
Water Depth	(ft)	----	----
SeaFloor Type		----	Silt
Coef. Friction		----	0.3
Force to Free (ST)		----	87.6

Figure I-10. Salvage Comparison Table.

APPENDIX J

PHASE III SECOND PULL OF WENDY

The enclosed figures present the POSSE model for the configuration of WENDY as she was at the time of the second pull into shallower water.

In preparation for this pull, all compartments aft of and including the engine room were pumped dry. To provide additional ground reaction reduction, the YFN was positioned end on over the bow and provided an estimated 120 Ltons of lift.

The pulling barge configuration was also altered in an attempt to gain an additional pulling force on the stern of WENDY and to ensure that the YC did not go aground on the small key roughly 50 yards away. Instead of using three hydraulic pullers on the YC, only two were used. The remaining leg of beach gear was run to the tow hawser of USS GRASP which was estimated to have a maximum pull of 70 tons. Together, an estimated 140 tons of force was to be applied to the stern of WENDY.

The estimated 160 Ltons of ground reaction remaining, as estimated by POSSE, meant that only 75 to 80 Ltons would be required to initiate movement of WENDY again. Although WENDY did start moving again, it was only after the full tension was applied by all units. It was noted that the lift applied by the YFN caused a noticable rise of WENDY's bow. As such, the plowing force could have been larger than estimated.

The lift provided by the YFN would fall off quickly as WENDY lost depth and once the tow hawser to the GRASP parted, WENDY, which had moved an additional 20 to 30 feet, immediately stopped moving.

FREIGHTER -- WENDY (SINKING on 1989) OOC POSSE-SALV V1.00
Rev. 0 (by: GAP) 02-24-1993

STRANDING on TWO PINNACLES
4/12

Damaged Compartments:

UPPER PEAK FORECASTLE LOWER PEAK TANK1 TANK2 STBD TANK2 PORT
TANK3C TANK4S TANK4P TANK5C

	DISPLACEMENT LTons	DRAFT AFT ft	DRAFT FWD ft	TRIM ft	HEEL deg.	UPRIGHT GMt ft
INTACT	3,611.6	21.055	24.093	3.037F	0.00	3.203
STRANDED	3,817.3	17.667	49.539	31.872F	0.00	-2.018

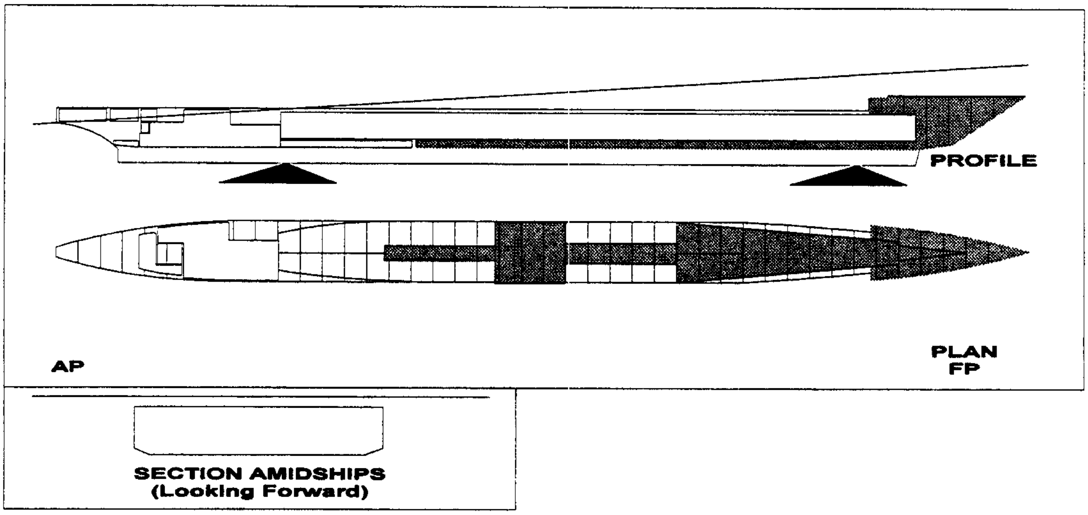

Figure J-1. Stranding on Two Pinnacles 4/12.

FREIGHTER -- WENDY (SINKING on 1989)
Rev. 0 (by: GAP)

OOC POSSE-SALV V1.00
02-24-1993

STRANDING on TWO PINNACLES
4/12

OBSERVED DATA

Draft at A.P.	---	
Draft at F.P.	---	
Static Heel Angle	0.000	deg
Tidal Height	0.000	ft

Specified Ground Contact	AFT PINNACLE		FWD PINNACLE	
Longitudinal Location	49.250F	ft-AP	197.000F	ft-AP
Transverse Location	0.000	ft-CL	0.000	ft-CL
Depth of Water Over Ground	25.000	ft	47.000	ft

COMPUTED DATA

Type of Ground Contact	AFT PINNACLE		FWD PINNACLE	
(R) Ground Reaction	66.9	LTons	91.1	LTons
(LCR) Long'l Ctr. of Grd. Reaction	49.250F	ft-AP	197.000F	ft-AP
Water Depth at LCR	25.000	ft	47.000	ft
Ht of Contact Pt. abv. Baseline	0.000	ft	0.000	ft
Aft Boundary of Ground Contact	48.750F	ft-AP	196.500F	ft-AP
Fwd Boundary of Ground Contact	49.750F	ft-AP	197.500F	ft-AP
(TCR) Transv. Ctr. of Grd. Reaction	0.000	ft-CL	0.000	ft-CL
Long'l Extent of Ground Contact	1.000	ft	1.000	ft
Transv. Extent of Ground Contact	1.000	ft	1.000	ft
Grounding Contact Area	1.000	ft2	1.000	ft2
Pressure on Hull	66.868	LT/ft	91.141	LT/ft

Neutral Load Point	---	
LBP	214.050	ft
LCF	14.853F	ft-AP
Mt1in	0.8	ft-LT/in
TPI	1.80	LT/in
(F) Force to Free	53.1	ST
Coef. of Friction	0.30	
Seafloor Type	SILT	

Figure J-2. Stranding on Two Pinnacles 4/12.

FREIGHTER -- WENDY (SINKING on 1989)
Rev. 0 (by: GAP)

OOC POSSE-SALV V1.00
02-24-1993

STRANDED CONDITION
4/12

ITEM	WEIGHT LTons	KG ft-BL	LCG ft-AP	TCG ft-CL	FSmom ft-LTons
Light Ship	800.0	13.000	80.000F	0.000	
Constant	5.6	2.986	8.624F	0.000	1.5
Bulk Cargo	100.0	13.000	120.000F	0.000	
Misc. Weight	-120.0	26.000	210.000F	0.000	0.0
Diesel Oil	17.6	3.764	113.152F	0.000	291.3
Fresh Water	13.1	1.944	92.533F	0.000	35.0
SW Ballast	2,795.2	11.959	115.944F	0.000	6,822.5
TOTALS	3,611.6	11.662	104.704F	0.000	7,150.3

		INTACT	AFTER OUTFLOW	AS STRANDED
Draft at A.P.	(ft)	21.055	----	17.667
Draft at F.P.	(ft)	24.093	----	49.539
Trim	(ft)	3.037F	----	31.872F
Draft at Aft Marks	(ft)	21.055	----	17.667
Draft at Fwd Marks	(ft)	24.092	----	49.531
Static Heel Angle	(deg)	0.00	----	0.00
Total Weight	(LT)	3,611.6	3,430.0	3,817.3
KG	(ft)	11.662	12.144	12.134
LCG	(ft-AP)	104.704F	102.189F	108.772F
TCG	(ft-CL)	0.000	0.000	0.000
Buoyancy	(LT)	3,611.6	----	3,659.3
KB	(ft)	----	----	12.469
LCB	(ft-AP)	102.330F	----	107.690F
TCB	(ft-CL)	----	----	0.000
KMt	(ft)	16.845	----	12.789
FSc	(ft)	1.980	----	2.076
GMt	(ft)	3.203	----	-2.018
Shear Force	(LT)	----	----	---
Bending Moment	(ft-LT)	----	----	----

AFTER OUTFLOW CONDITION:
Displacement, KG, LCG, TCG include the effects of fluid outflow & flooding without free-communication.
AS STRANDED CONDITION:
Displacement, KG, LCG, TCG include the effects of the flooded water at the equilibrium trim/heel.
Buoyancy, KB, LCB, TCB are for an intact hull at the equilibrium heel and drafts.
KMt is for the damaged hull at the upright flooded drafts.
F.S. correction accounts for the free surface of intact tanks and is corrected for outflow.

Figure J-3. Stranded Condition 4/12.

FREIGHTER -- WENDY (SINKING on 1989) OOC POSSE-SALV V1.00
Rev. 0 (by: GAP) 02-24-1993

TANK WEIGHT SUMMARY

Diesel Oil Tanks

TANK NAME	WEIGHT LTons	% Full	CAPACITY LTons	VOLUME bbls	NET VOL. bbls	API GRAV.	TEMP. oF	SP.VOL. bbls/LT	KG ft-BL	LCG ft-AP	TCG ft CL	F.S. ft-LTons
TANK3P	6.5	26.7	24.3	45.2	45.2	----	60.0	6.9465	2.037	135.861F	11.337P	74.9
TANK3S	6.5	26.7	24.3	45.2	45.2	----	60.0	6.9465	2.037	135.861F	11.337S	74.9
TANK4P	0.8	5.0	15.9	5.5	5.5	----	60.0	6.9465	2.048	116.157F	11.330P	51.4
TANK4S	0.8	5.0	15.9	5.5	5.5	----	60.0	6.9465	2.048	116.157F	11.330S	51.4
SETTLING	3.0	50.0	6.0	20.8	20.8	----	60.0	6.9465	12.190	12.822F	0.000	38.6
TOTALS	17.6	20.3	86.4	122.1	122.1				3.764	113.152F	0.000	291.3

Fresh Water Tanks

TANK NAME	WEIGHT LTons	% Full	CAPACITY LTons	VOLUME ft3	SP.VOL. ft3/LT	KG ft-BL	LCG ft-AP	TCG ft CL	F.S. ft-LTons
TANK5C	13.1	50.0	26.2	470.6	35.8814	1.944	92.533F	0.000	35.0
TOTALS	13.1	50.0	26.2	470.6		1.944	92.533F	0.000	35.0

SW Ballast Tanks

TANK NAME	WEIGHT LTons	% Full	CAPACITY LTons	VOLUME ft3	SP.VOL. ft3/LT	KG ft-BL	LCG ft-AP	TCG ft-CL	F.S. ft-LTons
STEERING	0.0	0.0	63.5	0.0	35.0062	19.408	4.011F	0.000	0.0
AFTER PEAK	0.0	0.0	30.1	0.0	35.0062	11.589	6.641F	0.000	0.0
AFT HOLD	0.0	0.0	69.0	0.0	35.0062	19.321	11.432F	1.483S	0.0
MISC 1C	0.0	0.0	15.9	0.0	35.0062	19.132	18.715F	1.061S	0.0
ENGINE RM	0.0	0.0	353.0	0.0	35.0062	13.228	31.553F	0.600S	0.0
MISC 2P	0.0	0.0	28.9	0.0	35.0062	18.829	39.622F	12.071P	0.0
FORECASTLE	0.0	0.0	122.5	0.0	35.0062	27.822	200.248F	0.000	0.0
UPPER PEAK	0.0	0.0	35.5	0.0	35.0062	19.570	206.052F	0.004P	0.0
LOWER PEAK	13.8	100.0	13.8	482.4	35.0062	9.257	203.504F	0.000	5.8
TANK1	40.6	100.0	40.6	1,422.6	35.0062	2.071	179.473F	0.000	67.4
TANK2 PORT	30.2	100.0	30.2	1,057.2	35.0062	2.011	156.880F	7.188P	45.6
TANK2 STBD	30.2	100.0	30.2	1,057.2	35.0062	2.011	156.880F	7.188S	45.6
TANK3C	52.0	100.0	52.0	1,820.1	35.0062	1.944	128.050F	0.000	54.9
TANK5P	42.5	100.0	42.5	1,486.4	35.0062	2.033	92.718F	10.114P	51.6
TANK5S	42.5	100.0	42.5	1,486.4	35.0062	2.033	92.718F	10.114S	51.6
TANK6P	42.5	100.0	42.5	1,486.7	35.0062	2.037	62.677F	6.483P	62.5
TANK6S	42.5	100.0	42.5	1,486.7	35.0062	2.037	62.677F	6.483S	62.5
CARGO	2,458.6	100.0	2,458.6	86,065.2	35.0062	13.280	115.784F	0.000	6,375.1
TOTALS	2,795.2	79.6	3,512.8	97,850.8		11.959	115.944F	0.000	6,822.5

Figure J-4. Tank Weight Summary (sheet 1 of 2).

FREIGHTER -- WENDY (SINKING on 1989) Rev. 0 (by: GAP)

OOC POSSE-SALV V1.00 02-24-1993

TANK WEIGHT SUMMARY

Constant

ITEM	WEIGHT LTons	KG ft-BL	LCG ft-AP	TCG ft-CL	F.S. ft-LTons
CEMENT SHAFT	5.6	2.986	8.624F	0.000	1.5
TOTALS	5.6	2.986	8.624F	0.000	1.5

Figure J-4. Tank Weight Summary (sheet 2 of 2).

FREIGHTER -- WENDY (SINKING on 1989) Rev. 0 (by: GAP)

OOC POSSE-SALV V1.00 02-24-1993

CARGO SUMMARY

BulkIn Hold

	WEIGHT LTons	VCG ft-BL	LCG ft-AP	TCG ft-CL	VOLUME ft3	S.F. ft3/LT
PAPER	100.0	13.000	120.000F	0.000	9,999.0	99.9900
Totals	100.0	13.000	120.000F	0.000	9,999.0	99.9900

Figure J-5. Cargo Summary (sheet 1 of 2).

FREIGHTER -- WENDY (SINKING on 1989) Rev. 0 (by: GAP)

OOC POSSE-SALV V1.00 02-24-1993

CARGO SUMMARY

Misc. Weights

ITEM	WEIGHT LTons	KG ft-BL	LCG ft-AP	TCG ft-CL	F.S. ft LTons	AFT BND ft-AP	FWD BND ft-AP
BOW LIFT	-120.0	26.000	210.000F	0.000	0.0	209.900F	210.100F
TOTALS	-120.0	26.000	210.000F	0.000	0.0		

Figure J-6. Cargo Summary (sheet 2 of 2).

FREIGHTER -- WENDY (SINKING on 1989)
Rev. 0 (by: GAP)

OOC POSSE-SALV V1.00
02-24-1993

FLUID OUTFLOW AFTER DAMAGE 4/12

COMPARTMENT	FLUID OUTFLOW LTons	SP.VOL. ft3/LT	-------INTACT DATA BEFORE OUTFLOW------- % FULL	KG ft	LCG ft-AP	TCG ft-CL	FSc ft	Data Source
UPPER PEAK	0.0	35.0063	0.0	0.000	107.025F	0.000	0.000	Load Case
FORECASTLE	0.0	35.0063	0.0	0.000	107.025F	0.000	0.000	Load Case
LOWER PEAK	13.8	35.0063	100.0	9.257	203.504F	0.000	0.002	Load Case
TANK1	40.6	35.0063	100.0	2.071	179.473F	0.000	0.019	Load Case
TANK2 STBD	30.2	35.0063	100.0	2.011	156.880F	7.188S	0.013	Load Case
TANK2 PORT	30.2	35.0063	100.0	2.011	156.880F	7.188P	0.013	Load Case
TANK3C	52.0	35.0063	100.0	1.944	128.050F	0.000	0.015	Load Case
TANK4S	0.8	39.0015	5.0	2.048	116.157F	11.330S	0.014	Load Case
TANK4P	0.8	39.0015	5.0	2.048	116.157F	11.330P	0.014	Load Case
TANK5C	13.1	35.8814	50.0	1.944	92.533F	0.000	0.010	Load Case
TOTALS	181.5						0.099	

Figure J-7. Fluid Outflow After Damage 4/12.

FLOODING AFTER DAMAGE (For Equilibrium at 0.0o Heel)

COMPARTMENT	SEAWATER LTons	OIL LTons	PERM.	SP.VOL. ft3/LT	KG ft	LCG ft-AP	TCG ft-CL	FSc ft	SOUNDING ft	SPECIFIED % Full	PRESSURE PsiG
UPPER PEAK	35.5	----	0.98	35.0063	19.570	206.052F	0.004P	0.000	[FREE]		---
FORECASTLE	122.5	----	0.98	35.0063	27.822	200.248F	0.000	0.000	[FREE]	---	-
LOWER PEAK	13.8	----	0.98	35.0063	9.257	203.504F	0.000	0.000	[FREE]	---	---
TANK1	40.6	----	0.99	35.0063	2.071	179.473F	0.000	0.000	[FREE]	---	---
TANK2 STBD	30.2	----	0.98	35.0063	2.011	156.880F	7.188S	0.000	[FREE]		---
TANK2 PORT	30.2	----	0.98	35.0063	2.011	156.880F	7.188P	0.000	[FREE]	---	---
TANK3C	52.0	----	0.98	35.0063	1.944	128.050F	0.000	0.000	[FREE]	---	
TANK4S	17.7	----	0.98	35.0063	2.048	116.157F	11.330S	0.000	[FREE]	---	---
TANK4P	17.7	----	0.98	35.0063	2.048	116.157F	11.330P	0.000	[FREE]	---	---
TANK5C	26.9	----	0.98	35.0063	1.944	92.533F	0.000	0.000	[FREE]	---	
TOTALS	387.2	0.0			12.044	167.078F	0.000	0.000			

Figure J-8. Flooding After Damage (For Equilibrium at 0.0o Heel).

FREIGHTER -- WENDY (SINKING on 1989) OOC POSSE-SALV V1.00
Rev. 0 (by: GAP) 02-24-1993

DAMAGE EVALUATION SUMMARY
4/12

Stranding Evaluation: (STRANDING on TWO PINNACLES)
Total Ground Reaction = 158.0 LTons Force to Free = 53.1 STons
Longl Center of Grd.R.= 134.473F ft-AP Bottom Type = Silt (Cf=0.30)

Summary of Breached Compartments:

BREACHED COMPARTMENTS	PERM.	FLOODED WATER LTons	% FULL (Intact)	SP.VOL. ft3/LT	OUTFLOW LTons
UPPER PEAK	0.980	35.5	0.0	----	----
FORECASTLE	0.980	122.5	0.0	----	----
LOWER PEAK	0.980	13.8	100.0	35.0063	13.8
TANK1	0.990	40.6	100.0	35.0063	40.6
TANK2 STBD	0.980	30.2	100.0	35.0063	30.2
TANK2 PORT	0.980	30.2	100.0	35.0063	30.2
TANK3C	0.980	52.0	100.0	35.0063	52.0
TANK4S	0.980	17.7	5.0	39.0015	0.8
TANK4P	0.980	17.7	5.0	39.0015	0.8
TANK5C	0.980	26.9	50.0	35.8814	13.1
TOTALS		387.2			181.5

OIL OUTFLOW = 1.6 LTons

Figure J-9. Damage Evaluation Summary 4/12.

FREIGHTER -- WENDY (SINKING on 1989)
Rev. 0 (by: GAP)

OOC POSSE-SALV V1.00
02-24-1993

DAMAGE EVALUATION SUMMARY
4/12

Stranding Evaluation: (STRANDING on TWO PINNACLES)
Total Ground Reaction = 158.0 LTons   Force to Free = 53.1 STons
Longl Center of Grd.R.= 134.473F ft-AP   Bottom Type = Silt (Cf=0.30)

Summary of Breached Compartments:

BREACHED COMPARTMENTS	PERM.	FLOODED WATER LTons	% FULL (Intact)	SP.VOL. ft3/LT	OUTFLOW LTons
UPPER PEAK	0.980	35.5	0.0	----	----
FORECASTLE	0.980	122.5	0.0	----	----
LOWER PEAK	0.980	13.8	100.0	35.0063	13.8
TANK1	0.990	40.6	100.0	35.0063	40.6
TANK2 STBD	0.980	30.2	100.0	35.0063	30.2
TANK2 PORT	0.980	30.2	100.0	35.0063	30.2
TANK3C	0.980	52.0	100.0	35.0063	52.0
TANK4S	0.980	17.7	5.0	39.0015	0.8
TANK4P	0.980	17.7	5.0	39.0015	0.8
TANK5C	0.980	26.9	50.0	35.8814	13.1
TOTALS		387.2			181.5

OIL OUTFLOW = 1.6 LTons

Figure J-9. Damage Evaluation Summary 4/12.

APPENDIX K

PHASE IV BARGE HEAVY BOW LIFT OF WENDY

The enclosed figures present the POSSE model for the configuration of WENDY during the attempts to heavy lift her bow to the surface using the YC and YFN. The first set includes the lift contribution provided by the forward compartments. The second set assumes no contribution from the forward compartments.

In preparation for the lifts, all compartments aft of and including the engine room were pumped dry. Both barges were positioned in tandem over the port and starboard sides of the bow. Five hydraulic pullers were rigged to perform a dynamic lift over the sides of the barges. An estimated maximum dynamic lift of 240 tons was expected to be provided by the pullers. In addition, the forecastle and upper peak tank forward were expected to be de-watered. This would have provided an additional 155 Ltons of lift.

Due to friction and binding losses, the actual load applied by the pullers to lift WENDY was probably closer to 100 Ltons and the forecastle and upper peak tank were unable to be pumped. As a result, the heavy lift as configured failed to produce any movement of the bow.

One item of interest noticed during the analysis. Divers reported the bow lifting during the earlier lift attempts. They also reported a gap between the hull and the sea bed from the middle of the engine room aft. During the modeling and analysis of this "pivot" point, it was noticed that significant changes in the amount of lift required to bring the bow up were calculated depending on where the pivot point was modeled. To be conservative, the final models put the pivot point at the stern-most point of the ship.

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STRANDING on AFT PINNACLE
DWFWD800: DEWATER FWD FOCSLE + UPPER PEAK + ER + LIFT

Damaged Compartments:

TANK1 TANK2 STBD TANK2 PORT TANK3C TANK4S TANK4P
TANK5C AFT HOLD STEERING AFTER PEAK

	DISPLACEMENT LTons	DRAFT AFT ft	DRAFT FWD ft	TRIM ft	HEEL deg.	UPRIGHT GMt ft
INTACT	3,678.6	20.204	25.838	5.634F	2.72P	1.999
STRANDED	3,864.9	21.551	31.891	10.340F	0.00	-2.709

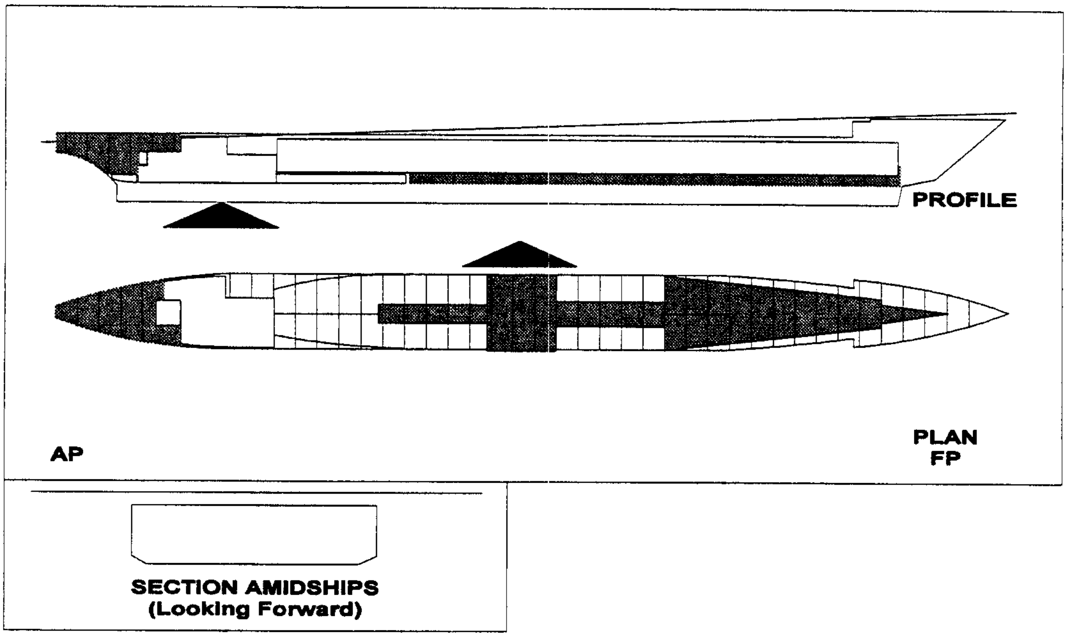

Figure K-1. Stranding on AFT Pinnacle DWFWD800: Dewater FWD Focsle + Upper Peak + Er + Lift

DAMAGE EVALUATION SUMMARY
DWFWD800: DEWATER FWD FOCSLE + UPPER PEAK + ER + LIFT

Stranding Evaluation: (STRANDING on AFT PINNACLE)
Total Ground Reaction = 141.1 LTons Force to Free = 47.4 STons
Longl Center of Grd.R.= 30.000F ft-AP Bottom Type = Silt (Cf=0.30)

Summary of Breached Compartments:

BREACHED COMPARTMENTS	PERM.	FLOODED WATER LTons	% FULL (Intact)	SP.VOL. ft3/LT	OUTFLOW LTons
TANK1	0.990	40.6	100.0	35.0063	40.6
TANK2 STBD	0.980	30.2	100.0	35.0063	30.2
TANK2 PORT	0.980	30.2	100.0	35.0063	30.2
TANK3C	0.980	52.0	100.0	35.0063	52.0
TANK4S	0.980	17.7	5.0	39.0015	0.8
TANK4P	0.980	17.7	5.0	39.0015	0.8
TANK5C	0.980	26.9	50.0	35.8814	13.1
AFT HOLD	0.980	58.0	0.0	----	----
STEERING	0.950	50.6	0.0	----	----
AFTER PEAK	0.980	30.1	0.0	----	----
TOTALS		354.1			167.7

OIL OUTFLOW = 1.6 LTons

Figure K-2. Damage Evaluation Summary DWFWD800: Dewater FWD Focsle + Upper Peak + Er + Lift

STRANDED CONDITION
DWFWD800: DEWATER FWD FOCSLE + UPPER PEAK + ER + LIFT

ITEM	WEIGHT LTons	KG ft-BL	LCG ft-AP	TCG ft-CL	FSmom ft-LTons
Light Ship	800.0	13.000	80.000F	0.000	
Constant	5.6	2.986	8.624F	0.000	1.5
Bulk Cargo	100.0	13.000	120.000F	0.000	
Misc. Weight	-240.0	9.250	184.000F	0.000	0.0
Diesel Oil	17.6	3.764	113.152F	0.000	291.3
Fresh Water	13.1	1.944	92.533F	0.000	35.0
SW Ballast	2,982.2	12.768	119.742F	0.117P	7,063.1
TOTALS	3,678.6	12.958	106.615F	0.095P	7,390.8

		INTACT	AFTER OUTFLOW	AS STRANDED
Draft at A.P.	(ft)	20.204	----	21.551
Draft at F.P.	(ft)	25.838	----	31.891
Trim	(ft)	5.634F	----	10.340F
Draft at Aft Marks	(ft)	20.204	----	21.551
Draft at Fwd Marks	(ft)	25.837	----	31.889
Static Heel Angle	(deg)	2.72P	----	0.00
Total Weight	(LT)	3,678.6	3,510.8	3,864.9
KG	(ft)	12.958	13.482	12.974
LCG	(ft-AP)	106.615F	104.638F	103.105F
TCG	(ft-CL)	0.095P	0.099P	0.067P
Buoyancy	(LT)	3,678.6	----	3,723.8
KB	(ft)	----	----	12.600
LCB	(ft-AP)	102.261F	----	105.934F
TCB	(ft-CL)	----	----	0.000
KMt	(ft)	16.966	----	13.427
FSc	(ft)	2.009	----	2.089
GMt	(ft)	1.999	----	-2.709
Shear Force	(LT)	----	----	----
Bending Moment	(ft-LT)	----	----	----

AFTER OUTFLOW CONDITION:
Displacement, KG, LCG, TCG include the effects of fluid outflow & flooding without free-communication.
AS STRANDED CONDITION:
Displacement, KG, LCG, TCG include the effects of the flooded water at the equilibrium trim/heel.
Buoyancy, KB, LCB, TCB are for an intact hull at the equilibrium heel and drafts.
KMt is for the damaged hull at the upright flooded drafts.
F.S. correction accounts for the free surface of intact tanks and is corrected for outflow.

Figure K-4. Stranded Condition DWFWD800: Dewater FWD Focsle + Upper Peak + Er + Lift

FLUID OUTFLOW AFTER DAMAGE
DWFWD800: DEWATER FWD FOCSLE + UPPER PEAK + ER + LIFT

	FLUID		-------INTACT DATA BEFORE OUTFLOW-------					
	OUTFLOW	SP.VOL.	%	KG	LCG	TCG	FSc	
COMPARTMENT	LTons	ft3/LT	FULL	ft	ft-AP	ft-CL	ft	Data Source
TANK1	40.6	35.0063	100.0	2.071	179.473F	0.000	0.018	Load Case
TANK2 STBD	30.2	35.0063	100.0	2.011	156.880F	7.188S	0.012	Load Case
TANK2 PORT	30.2	35.0063	100.0	2.011	156.880F	7.188P	0.012	Load Case
TANK3C	52.0	35.0063	100.0	1.944	128.050F	0.000	0.015	Load Case
TANK4S	0.8	39.0015	5.0	2.048	116.157F	11.330S	0.014	Load Case
TANK4P	0.8	39.0015	5.0	2.048	116.157F	11.330P	0.014	Load Case
TANK5C	13.1	35.8814	50.0	1.944	92.533F	0.000	0.010	Load Case
AFT HOLD	0.0	35.0063	0.0	0.000	107.025F	0.000	0.000	Load Case
STEERING	0.0	35.0063	0.0	0.000	107.025F	0.000	0.000	Load Case
AFTER PEAK	0.0	35.0063	0.0	0.000	107.025F	0.000	0.000	Load Case
TOTALS	167.7						0.095	

Figure K-5. Fluid Outflow After Damage DWFWD800: Dewater FWD Focsle + Upper Peak + ER + Lift

FLOODING AFTER DAMAGE
(For Equilibrium at 0.0o Heel)

	SEAWATER	OIL		SP.VOL.	KG	LCG	TCG	FSc	SOUNDING	SPECIFIED	PRESSURE
COMPARTMENT	LTons	LTons	PERM.	ft3/LT	ft	ft-AP	ft-CL	ft	ft	% Full	PsiG
TANK1	40.6	----	0.99	35.0063	2.071	179.473F	0.000	0.000	[FREE]	---	---
TANK2 STBD	30.2	----	0.98	35.0063	2.011	156.880F	7.188S	0.000	[FREE]	---	---
TANK2 PORT	30.2	----	0.98	35.0063	2.011	156.880F	7.188P	0.000	[FREE]	---	---
TANK3C	52.0	----	0.98	35.0063	1.944	128.050F	0.000	0.000	[FREE]	---	
TANK4S	17.7	----	0.98	35.0063	2.048	116.157F	11.330S	0.000	[FREE]	--	---
TANK4P	17.7	----	0.98	35.0063	2.048	116.157F	11.330P	0.000	[FREE]		---
TANK5C	26.9	----	0.98	35.0063	1.944	92.533F	0.000	0.000	[FREE]	---	---
AFT HOLD	58.0	----	0.98	35.0063	18.764	11.585F	1.557S	0.166	[FREE]	---	---
STEERING	50.6	----	0.95	35.0063	18.646	4.311F	0.000	0.080	[FREE]	---	---
AFTER PEAK	30.1	----	0.98	35.0063	11.589	6.641F	0.000	0.000	[FREE]	---	---
TOTALS	354.1	0.0			7.942	87.908F	0.255S	0.246			

Figure K-6. Flooding After Damage (For Equilibrium at 0.0o Heel).

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TANK WEIGHT SUMMARY

Diesel Oil Tanks

TANK NAME	WEIGHT LTons	% Full	CAPACITY LTons	VOLUME bbls	NET VOL. bbls	API GRAV.	TEMP. oF	SP.VOL. bbls/LT	KG ft-BL	LCG ft-AP	TCG ft-CL	F.S. ft LTons
TANK3P	6.5	26.7	24.3	45.2	45.2	----	60.0	6.9465	2.037	135.861F	11.337P	74.9
TANK3S	6.5	26.7	24.3	45.2	45.2	----	60.0	6.9465	2.037	135.861F	11.337S	74.9
TANK4P	0.8	5.0	15.9	5.5	5.5	----	60.0	6.9465	2.048	116.157F	11.330P	51.4
TANK4S	0.8	5.0	15.9	5.5	5.5	----	60.0	6.9465	2.048	116.157F	11.330S	51.4
SETTLING	3.0	50.0	6.0	20.8	20.8	----	60.0	6.9465	12.190	12.822F	0.000	38.6
TOTALS	17.6	20.3	86.4	122.1	122.1				3.764	113.152F	0.000	291.3

Fresh Water Tanks

TANK NAME	WEIGHT LTons	% Full	CAPACITY LTons	VOLUME ft3	SP.VOL. ft3/LT	KG ft-BL	LCG ft-AP	TCG ft-CL	F.S. ft-LTons
TANK5C	13.1	50.0	26.2	470.6	35.8814	1.944	92.533F	0.000	35.0
TOTALS	13.1	50.0	26.2	470.6		1.944	92.533F	0.000	35.0

SW Ballast Tanks

TANK NAME	WEIGHT LTons	% Full	CAPACITY LTons	VOLUME ft3	SP.VOL. ft3/LT	KG ft-BL	LCG ft-AP	TCG ft-CL	F.S. ft-LTons
STEERING	0.0	0.0	63.5	0.0	35.0062	19.408	4.011F	0.000	0.0
AFTER PEAK	0.0	0.0	30.1	0.0	35.0062	11.589	6.641F	0.000	0.0
AFT HOLD	0.0	0.0	68.0	0.0	35.0062	19.321	11.432F	1.483S	0.0
MISC 1C	0.0	0.0	15.9	0.0	35.0062	19.132	18.715F	1.061S	0.0
ENGINE RM	0.0	0.0	353.0	0.0	35.0062	13.228	31.553F	0.600S	0.0
MISC 2P	28.9	100.0	28.9	1,012.4	35.0062	18.829	39.622F	12.071P	21.6
FORECASTLE	122.5	100.0	122.5	4,289.3	35.0062	27.822	200.248F	0.000	202.1
UPPER PEAK	35.5	100.0	35.5	1,244.5	35.0062	19.570	206.052F	0.004P	16.8
LOWER PEAK	13.8	100.0	13.8	482.4	35.0062	9.257	203.504F	0.000	5.8
TANK1	40.6	100.0	40.6	1,422.6	35.0062	2.071	179.473F	0.000	67.4
TANK2 PORT	30.2	100.0	30.2	1,057.2	35.0062	2.011	156.880F	7.188P	45.6
TANK2 STBD	30.2	100.0	30.2	1,057.2	35.0062	2.011	156.880F	7.188S	45.6
TANK3C	52.0	100.0	52.0	1,820.1	35.0062	1.944	128.050F	0.000	54.9
TANK5P	42.5	100.0	42.5	1,486.4	35.0062	2.033	92.718F	10.114P	51.6
TANK5S	42.5	100.0	42.5	1,486.4	35.0062	2.033	92.718F	10.114S	51.6
TANK6P	42.5	100.0	42.5	1,486.7	35.0062	2.037	62.677F	6.483P	62.5
TANK6S	42.5	100.0	42.5	1,486.7	35.0062	2.037	62.677F	6.483S	62.5
CARGO	2,458.6	100.0	2,458.6	86,065.2	35.0062	13.280	115.784F	0.000	6,375.1
TOTALS	2,982.2	84.9	3,512.8	104,396.9		12.768	119.742F	0.117P	7,063.1

Figure K-7a. Tank Weight Summary (sheet 1 of 2).

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TANK WEIGHT SUMMARY

Constant

ITEM	WEIGHT LTons	KG ft-BL	LCG ft-AP	TCG ft-CL	F.S. ft-LTons
CEMENT SHAFT	5.6	2.986	8.624F	0.000	1.5
TOTALS	5.6	2.986	8.624F	0.000	1.5

Figure K-7b. Tank Weight Summary (sheet 2 of 2).

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CARGO SUMMARY

BulkIn Hold

	WEIGHT LTons	VCG ft-BL	LCG ft-AP	TCG ft-CL	VOLUME ft3	S.F. ft3/LT
PAPER	100.0	13.000	120.000F	0.000	9,999.0	99.9900
Totals	100.0	13.000	120.000F	0.000	9,999.0	99.9900

Figure K-8a. Cargo Summary (sheet 1 of 3).

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CARGO SUMMARY

Misc. Weights

ITEM	WEIGHT LTons	KG ft-BL	LCG ft-AP	TCG ft-CL	F.S. ft-LTons	AFT END ft-AP	FWD END ft-AP
CHAIN 1	-90.0	23.000	200.000F	0.000	0.0	183.596F	216.404F
CHAIN 2	-60.0	1.000	184.000F	0.000	0.0	168.596F	201.404F
CHAIN 3	-90.0	1.000	168.000F	0.000	0.0	151.596F	184.404F
TOTALS	-240.0	9.250	184.000F	0.000	0.0		

Figure K-8b. Cargo Summary (sheet 2 of 3).

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CARGO SUMMARY

Misc. Weights

ITEM	WEIGHT LTons	KG ft-BL	LCG ft-AP	TCG ft-CL	F.S. ft-LTons	AFT BND ft-AP	FWD BND ft-AP
CHAIN 1	-90.0	23.000	200.000F	0.000	0.0	183.596F	216.404F
CHAIN 2	-60.0	1.000	184.000F	0.000	0.0	168.596F	201.404F
CHAIN 3	-90.0	1.000	168.000F	0.000	0.0	151.596F	184.404F
TOTALS	-240.0	9.250	184.000F	0.000	0.0		

Figure K-8c. Cargo Summary (sheet 3 of 3).

DAMAGE EVALUATION SUMMARY
DWFWD800: DEWATER FWD FOCSLE + UPPER PEAK + ER + LIFT

Stranding Evaluation: (STRANDING on AFT PINNACLE)
Total Ground Reaction = 155.2 LTons Force to Free = 52.2 STons
Longl Center of Grd.R.= 30.000F ft-AP Bottom Type = Silt (Cf=0.30)

Summary of Breached Compartments:

BREACHED COMPARTMENTS	PERM.	FLOODED WATER LTons	% FULL (Intact)	SP.VOL. ft3/LT	OUTFLOW LTons
TANK1	0.990	40.6	100.0	35.0063	40.6
TANK2 STBD	0.980	30.2	100.0	35.0063	30.2
TANK2 PORT	0.980	30.2	100.0	35.0063	30.2
TANK3C	0.980	52.0	100.0	35.0063	52.0
TANK4S	0.980	17.7	5.0	39.0015	0.8
TANK4P	0.980	17.7	5.0	39.0015	0.8
TANK5C	0.980	26.9	50.0	35.8814	13.1
AFT HOLD	0.980	67.8	0.0	----	----
STEERING	0.950	63.5	0.0	----	----
AFTER PEAK	0.980	30.1	0.0	----	----
TOTALS		376.8			167.7

OIL OUTFLOW = 1.6 LTons

Figure K-9. Damage Evaluation Summary DWFWD800: Dewater FWD Focsle + Upper Peak + Er + Lift

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STRANDING on AFT PINNACLE
DWFWD800: DEWATER FWD FOCSLE + UPPER PEAK + ER + LIFT

OBSERVED DATA

Draft at A.P.	---	
Draft at F.P.	---	
Static Heel Angle	0.000	deg
Tidal Height	0.000	ft

Specified Ground Contact	AFT PINNACLE		FWD PINNACLE	
Longitudinal Location	30.000F	ft-AP	200.000F	ft-AP
Transverse Location	0.000	ft-CL	0.000	ft-CL
Depth of Water Over Ground	23.000	ft	48.000	ft

COMPUTED DATA

Type of Ground Contact	AFT PINNACLE	
(R) Ground Reaction	155.2	LTons
(LCR) Long'l Ctr. of Grd. Reaction	30.000F	ft-AP
Water Depth at LCR	23.000	ft
Ht of Contact Pt. abv. Baseline	0.000	ft
Aft Boundary of Ground Contact	29.500F	ft-AP
Fwd Boundary of Ground Contact	30.500F	ft-AP
(TCR) Transv. Ctr. of Grd. Reaction	1.606P	ft-CL
Long'l Extent of Ground Contact	1.000	ft
Transv. Extent of Ground Contact	1.000	ft
Grounding Contact Area	1.000	ft2
Pressure on Hull	155.232	LT/ft

Neutral Load Point	Fwd FP	
LBP	214.050	ft
LCF	117.800F	ft-AP
Mt1in	152.4	ft-LT/in
TPI	7.35	LT/in
(F) Force to Free	52.2	ST
Coef. of Friction	0.30	
Seafloor Type	SILT	

Note: Vessel trims about AFT PINNACLE

Figure K-10. Stranding on AFT Pinnacle DWFWD800: Dewater FWD Focsle + Upper Peak + Er + Lift.

STRANDED CONDITION
DWFWD800: DEWATER FWD FOCSLE + UPPER PEAK + ER + LIFT

ITEM	WEIGHT LTons	KG ft-BL	LCG ft-AP	TCG ft-CL	FSmom ft-LTons
Light Ship	800.0	13.000	80.000F	0.000	
Constant	5.6	2.986	8.624F	0.000	1.5
Bulk Cargo	100.0	13.000	120.000F	0.000	
Misc. Weight	-240.0	9.250	184.000F	0.000	0.0
Diesel Oil	17.6	3.764	113.152F	0.000	291.3
Fresh Water	13.1	1.944	92.533F	0.000	35.0
SW Ballast	2,824.2	12.030	115.163F	0.124P	6,844.1
TOTALS	3,520.5	12.374	102.352F	0.099P	7,171.9

		INTACT	AFTER OUTFLOW	AS STRANDED
Draft at A.P.	(ft)	22.023	----	23.234
Draft at F.P.	(ft)	21.934	----	21.567
Trim	(ft)	0.089A	----	1.666A
Draft at Aft Marks	(ft)	22.023	----	23.234
Draft at Fwd Marks	(ft)	21.934	----	21.567
Static Heel Angle	(deg)	2.50P	----	0.00
Total Weight	(LT)	3,520.5	3,352.7	3,729.5
KG	(ft)	12.374	12.893	12.481
LCG	(ft-AP)	102.352F	100.068F	98.342F
TCG	(ft-CL)	0.099P	0.104P	0.067P
Buoyancy	(LT)	3,520.5	----	3,574.3
KB	(ft)	----	----	12.007
LCB	(ft-AP)	102.423F	----	101.243F
TCB	(ft-CL)	----	----	0.000
KMt	(ft)	16.679	----	14.640
FSc	(ft)	2.037	----	2.133
GMt	(ft)	2.267	----	-1.012
Shear Force	(LT)	----	----	----
Bending Moment	(ft-LT)	----	----	----

AFTER OUTFLOW CONDITION:
Displacement, KG, LCG, TCG include the effects of fluid outflow & flooding without free-communication.
AS STRANDED CONDITION:
Displacement, KG, LCG, TCG include the effects of the flooded water at the equilibrium trim/heel.
Buoyancy, KB, LCB, TCB are for an intact hull at the equilibrium heel and drafts.
KMt is for the damaged hull at the upright flooded drafts.
F.S. correction accounts for the free surface of intact tanks and is corrected for outflow.

Figure K-11. Stranded Condition DWFWD800: Dewater FWD Focsle + Upper Peak + Er + Lift.

FLUID OUTFLOW AFTER DAMAGE
DWFWD800: DEWATER FWD FOCSLE + UPPER PEAK + ER + LIFT

COMPARTMENT	FLUID OUTFLOW LTons	SP.VOL. ft3/LT	---INTACT DATA BEFORE OUTFLOW--- % FULL	KG ft	LCG ft-AP	TCG ft-CL	FSc ft	Data Source
TANK1	40.6	35.0063	100.0	2.071	179.473F	0.000	0.019	Load Case
TANK2 STBD	30.2	35.0063	100.0	2.011	156.880F	7.188S	0.013	Load Case
TANK2 PORT	30.2	35.0063	100.0	2.011	156.880F	7.188P	0.013	Load Case
TANK3C	52.0	35.0063	100.0	1.944	128.050F	0.000	0.016	Load Case
TANK4S	0.8	39.0015	5.0	2.048	116.157F	11.330S	0.015	Load Case
TANK4P	0.8	39.0015	5.0	2.048	116.157F	11.330P	0.015	Load Case
TANK5C	13.1	35.8814	50.0	1.944	92.533F	0.000	0.010	Load Case
AFT HOLD	0.0	35.0063	0.0	0.000	107.025F	0.000	0.000	Load Case
STEERING	0.0	35.0063	0.0	0.000	107.025F	0.000	0.000	Load Case
AFTER PEAK	0.0	35.0063	0.0	0.000	107.025F	0.000	0.000	Load Case
TOTALS	167.7						0.100	

Figure K-12. Fluid Outflow After Damage DWFWD800: Dewater FWD Focsle + Upper Peak + Er + Lift

FLOODING AFTER DAMAGE
(For Equilibrium at 0.0o Heel)

COMPARTMENT	SEAWATER LTons	OIL LTons	PERM.	SP.VOL. ft3/LT	KG ft	LCG ft-AP	TCG ft-CL	FSc ft	SOUNDING ft	SPECIFIED % Full	PRESSURE PsiG
TANK1	40.6	----	0.99	35.0063	2.071	179.473F	0.000	0.000	[FREE]	---	---
TANK2 STBD	30.2	----	0.98	35.0063	2.011	156.880F	7.188S	0.000	[FREE]	---	---
TANK2 PORT	30.2	----	0.98	35.0063	2.011	156.880F	7.188P	0.000	[FREE]	---	---
TANK3C	52.0	----	0.98	35.0063	1.944	128.050F	0.000	0.000	[FREE]	---	---
TANK4S	17.7	----	0.98	35.0063	2.048	116.157F	11.330S	0.000	[FREE]	---	---
TANK4P	17.7	----	0.98	35.0063	2.048	116.157F	11.330P	0.000	[FREE]	---	---
TANK5C	26.9	----	0.98	35.0063	1.944	92.533F	0.000	0.000	[FREE]	---	---
AFT HOLD	67.8	----	0.98	35.0063	19.311	11.419F	1.472S	0.120	[FREE]	---	---
STEERING	63.5	----	0.95	35.0063	19.408	4.011F	0.000	0.004	[FREE]	---	---
AFTER PEAK	30.1	----	0.98	35.0063	11.589	6.641F	0.000	0.000	[FREE]	---	---
TOTALS	376.8	0.0			8.817	82.975F	0.265S	0.123			

Figure K-13. Flooding After Damage (For Equilibrium at 0.0o Heel).

Rev. 0 (by: GAP)

TANK WEIGHT SUMMARY

Diesel Oil Tanks

TANK NAME	WEIGHT LTons	% Full	CAPACITY LTons	VOLUME bbls	NET VOL. bbls	API GRAV.	TEMP. oF	SP.VOL. bbls/LT	KG ft-BL	LCG ft-AP	TCG ft-CL	F.S. ft-LTons
TANK3P	6.5	26.7	24.3	45.2	45.2	----	60.0	6.9465	2.037	135.861F	11.337P	74.9
TANK3S	6.5	26.7	24.3	45.2	45.2	----	60.0	6.9465	2.037	135.861F	11.337S	74.9
TANK4P	0.8	5.0	15.9	5.5	5.5	----	60.0	6.9465	2.048	116.157F	11.330P	51.4
TANK4S	0.8	5.0	15.9	5.5	5.5	----	60.0	6.9465	2.048	116.157F	11.330S	51.4
SETTLING	3.0	50.0	6.0	20.8	20.8	----	60.0	6.9465	12.190	12.822F	0.000	36.6
TOTALS	17.6	20.3	86.4	122.1	122.1				3.764	113.152F	0.000	291.3

Fresh Water Tanks

TANK NAME	WEIGHT LTons	% Full	CAPACITY LTons	VOLUME ft3	SP.VOL. ft3/LT	KG ft-BL	LCG ft-AP	TCG ft-CL	F.S. ft-LTons
TANK5C	13.1	50.0	26.2	470.6	35.8814	1.944	92.533F	0.000	35.0
TOTALS	13.1	50.0	26.2	470.6		1.944	92.533F	0.000	35.0

SW Ballast Tanks

TANK NAME	WEIGHT LTons	% Full	CAPACITY LTons	VOLUME ft3	SP.VOL. ft3/LT	KG ft-BL	LCG ft-AP	TCG ft-CL	F.S. ft LTons
STEERING	0.0	0.0	63.5	0.0	35.0062	19.408	4.011F	0.000	0.0
AFTER PEAK	0.0	0.0	30.1	0.0	35.0062	11.589	6.641F	0.000	0.0
AFT HOLD	0.0	0.0	68.0	0.0	35.0062	19.321	11.432F	1.483S	0.0
MISC 1C	0.0	0.0	15.9	0.0	35.0062	19.132	18.715F	1.061S	0.0
ENGINE RM	0.0	0.0	353.0	0.0	35.0062	13.228	31.553F	0.600S	0.0
MISC 2P	28.9	100.0	28.9	1,012.4	35.0062	18.829	39.622F	12.071P	21.6
FORECASTLE	0.0	0.0	122.5	0.0	35.0062	27.822	200.248F	0.000	0.0
UPPER PEAK	0.0	0.0	35.5	0.0	35.0062	19.570	206.052F	0.004P	0.0
LOWER PEAK	13.8	100.0	13.8	482.4	35.0062	9.257	203.504F	0.000	5.8
TANK1	40.6	100.0	40.6	1,422.6	35.0062	2.071	179.473F	0.000	67.4
TANK2 PORT	30.2	100.0	30.2	1,057.2	35.0062	2.011	156.880F	7.188P	45.6
TANK2 STBD	30.2	100.0	30.2	1,057.2	35.0062	2.011	156.880F	7.188S	45.6
TANK3C	52.0	100.0	52.0	1,820.1	35.0062	1.944	128.050F	0.000	54.9
TANK5P	42.5	100.0	42.5	1,486.4	35.0062	2.033	92.718F	10.114P	51.6
TANK5S	42.5	100.0	42.5	1,486.4	35.0062	2.033	92.718F	10.114S	51.6
TANK6P	42.5	100.0	42.5	1,486.7	35.0062	2.037	62.677F	6.483P	62.5
TANK6S	42.5	100.0	42.5	1,486.7	35.0062	2.037	62.677F	6.483S	62.5
CARGO	2,458.6	100.0	2,458.6	86,065.2	35.0062	13.280	115.784F	0.000	6,375.1
TOTALS	2,824.2	80.4	3,512.8	98,863.2		12.030	115.163F	0.124P	6,844.1

Figure K-14a. Tank Weight Summary (sheet 1 of 2).

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TANK WEIGHT SUMMARY

Constant

ITEM	WEIGHT LTons	KG ft-BL	LCG ft-AP	TCG ft-CL	F.S. ft-LTons
CEMENT SHAFT	5.6	2.986	8.624F	0.000	1.5
TOTALS	5.6	2.986	8.624F	0.000	1.5

Figure K-14b. Tank Weight Summary (sheet 2 of 2).

Rev. 0 (by: GAP) 02-24-1993

CARGO SUMMARY

BulkIn Hold

	WEIGHT LTons	VCG ft-BL	LCG ft-AP	TCG ft-CL	VOLUME ft3	S.F. ft3/LT
PAPER	100.0	13.000	120.000F	0.000	9,999.0	99.9900
Totals	100.0	13.000	120.000F	0.000	9,999.0	99.9900

Figure K-15a. Cargo Summary (sheet 1 of 2).

Rev. 0 (by: GAP) 02-24-1993

CARGO SUMMARY

Misc. Weights

ITEM	WEIGHT LTons	KG ft-BL	LCG ft-AP	TCG ft-CL	F.S. ft-LTons	AFT BND ft-AP	FWD BND ft-AP
CHAIN 1	90.0	23.000	200.000F	0.000	0.0	183.596F	216.404F
CHAIN 2	-60.0	1.000	184.000F	0.000	0.0	168.596F	201.404F
CHAIN 3	-90.0	1.000	168.000F	0.000	0.0	151.596F	184.404F
TOTALS	240.0	9.250	184.000F	0.000	0.0		

Figure K-15b. Cargo Summary (sheet 2 of 2).

APPENDIX L

PHASE IV BARGE/GRASP HEAVY BOW LIFT OF WENDY

The enclosed figures present the POSSE model for the configuration of WENDY during the attempts to heavy lift her bow to the surface using the YC, YFN and USS GRASP.

In preparation for the lifts, all compartments aft of and including the engine room were pumped dry. Both barges were positioned in tandem over the port and starboard sides of the bow. Four hydraulic pullers were rigged to perform a dynamic lift over the sides of the barges. An estimated maximum dynamic lift of 180 tons was expected to be provided by the pullers. The USS GRASP was rigged for a single 75-ton dynamic lift over her starboard bow roller. In addition, the forecastle and upper peak tank forward were expected to be de-watered. This would have provided an additional 155 Ltons of lift.

Due to friction and binding losses, the actual load applied by the pullers to lift WENDY was probably closer to 100 Ltons and the forecastle and upper peak tank were unable to be pumped. As a result, the heavy lift as configured failed to produce any movement of the bow. Cracking of the bow structure was noticed by divers inspecting for leaks in the forecastle. As a result, the decision was made not to attempt another lift using the GRASP in a 150-ton lift configuration.

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STRANDING on TWO PINNACLES
DWFWD800: DEWATER FWD FOCSLE + UPPER PEAK + ER + LIFT

Damaged Compartments:

TANK1 TANK2 STBD TANK2 PORT TANK3C TANK4S TANK4P
TANK5C

	DISPLACEMENT LTons	DRAFT AFT ft	DRAFT FWD ft	TRIM ft	HEEL deg.	UPRIGHT GMt ft
INTACT	3,663.6	20.526	25.295	4.769F	2.43P	2.245
STRANDED	3,711.2	11.333	51.327	39.994F	0.00	-2.695

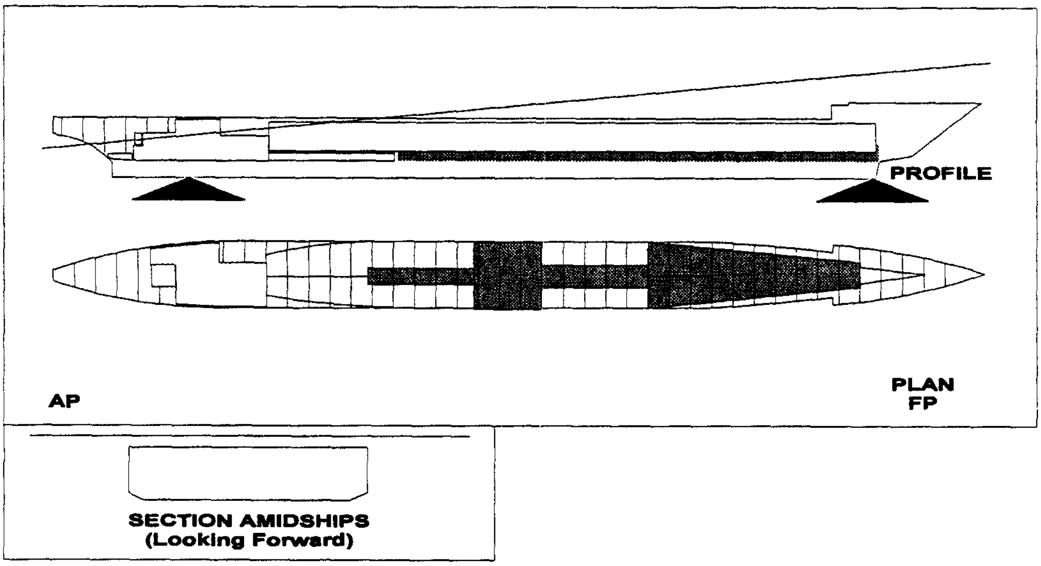

Figure L-1. Strandings on Two Pinnacles DWFWD800: Dewater FWD Focsle + Upper Peak + Er + Lift

FREIGHTER -- WENDY (SINKING on 1989) OOC POSSE-SALV V1.00
Rev. 0 (by: GAP) 02-24-1993

DAMAGE EVALUATION SUMMARY
DWFWD800: DEWATER FWD FOCSLE + UPPER PEAK + ER + LIFT

Stranding Evaluation: (STRANDING on TWO PINNACLES)
Total Ground Reaction = 253.5 LTons Force to Free = 85.2 STons
Longl Center of Grd.R.= 22.040F ft-AP Bottom Type = Silt (Cf=0.30)

Summary of Breached Compartments:

BREACHED COMPARTMENTS	PERM.	FLOODED WATER LTons	% FULL (Intact)	SP.VOL. ft3/LT	OUTFLOW LTons
TANK1	0.990	40.6	100.0	35.0063	40.6
TANK2 STBD	0.980	30.2	100.0	35.0063	30.2
TANK2 PORT	0.980	30.2	100.0	35.0063	30.2
TANK3C	0.980	52.0	100.0	35.0063	52.0
TANK4S	0.980	17.7	5.0	39.0015	0.8
TANK4P	0.980	17.7	5.0	39.0015	0.8
TANK5C	0.980	26.9	50.0	35.8814	13.1
TOTALS		215.4			167.7

OIL OUTFLOW = 1.6 LTons

Figure L-2. Damage Evaluation Summary DWFWD800: Dewater FWD Focsle + Upper Peak + Er + Lift

FREIGHTER -- WENDY (SINKING on 1989) OOC POSSE-SALV V1.00
Rev. 0 (by: GAP) 02-24-1993

STRANDING on TWO PINNACLES
DWFWD800: DEWATER FWD FOCSLE + UPPER PEAK + ER + LIFT

OBSERVED DATA

Draft at A.P.	---	
Draft at F.P.	---	
Static Heel Angle	0.000	deg
Tidal Height	0.000	ft

Specified Ground Contact	AFT PINNACLE		FWD PINNACLE	
Longitudinal Location	20.000F	ft-AP	200.000F	ft-AP
Transverse Location	0.000	ft-CL	0.000	ft-CL
Depth of Water Over Ground	15.000	ft	48.000	ft

COMPUTED DATA

Type of Ground Contact	AFT PINNACLE		FWD PINNACLE	
(R) Ground Reaction	250.6	LTons	2.9	LTons
(LCR) Long'l Ctr. of Grd. Reaction	20.000F	ft-AP	200.000F	ft-AP
Water Depth at LCR	15.070	ft	47.951	ft
Ht of Contact Pt. abv. Baseline	0.000	ft	0.751	ft
Aft Boundary of Ground Contact	19.500F	ft-AP	199.500F	ft-AP
Fwd Boundary of Ground Contact	20.500F	ft-AP	200.500F	ft-AP
(TCR) Transv. Ctr. of Grd. Reaction	1.378P	ft-CL	1.378P	ft-CL
Long'l Extent of Ground Contact	1.000	ft	1.000	ft
Transv. Extent of Ground Contact	1.000	ft	1.000	ft
Grounding Contact Area	1.000	ft2	1.000	ft2
Pressure on Hull	250.596	LT/ft	2.873	LT/ft

Neutral Load Point	---	
LBP	214.050	ft
LCF	30.634F	ft-AP
Mt1in	2.3	ft-LT/in
TPI	3.26	LT/in
(F) Force to Free	85.2	ST
Coef. of Friction	0.30	
Seafloor Type	SILT	

Figure L-3. Stranding on Two Pinnacles DWFWD800: Dewater FWD Focsle + Upper Peak + Er + Lift.

FREIGHTER -- WENDY (SINKING on 1989) OOC POSSE-SALV V1.00
Rev. 0 (by: GAP) 02-24-1993

STRANDED CONDITION
DWFWD800: DEWATER FWD FOCSLE + UPPER PEAK + ER + LIFT

ITEM	WEIGHT LTons	KG ft-BL	LCG ft-AP	TCG ft-CL	FSmom ft-LTons
Light Ship	800.0	13.000	80.000F	0.000	
Constant	5.6	2.986	8.624F	0.000	1.5
Bulk Cargo	100.0	13.000	120.000F	0.000	
Misc. Weight	-255.0	13.510	188.706F	0.000	0.0
Diesel Oil	17.6	3.764	113.152F	0.000	291.3
Fresh Water	13.1	1.944	92.533F	0.000	35.0
SW Ballast	2,982.2	12.768	119.742F	0.117P	7,063.1
TOTALS	3,663.6	12.677	105.971F	0.095P	7,390.8

		INTACT	AFTER OUTFLOW	AS STRANDED
Draft at A.P.	(ft)	20.526	----	11.333
Draft at F.P.	(ft)	25.295	----	51.327
Trim	(ft)	4.769F	----	39.994F
Draft at Aft Marks	(ft)	20.526	----	11.333
Draft at Fwd Marks	(ft)	25.294	----	51.318
Static Heel Angle	(deg)	2.43P	----	0.00
Total Weight	(LT)	3,663.6	3,495.8	3,711.2
KG	(ft)	12.677	13.189	12.540
LCG	(ft-AP)	105.971F	103.954F	106.014F
TCG	(ft-CL)	0.095P	0.100P	0.094P
Buoyancy	(LT)	3,663.6	----	3,457.7
KB	(ft)	----	----	12.088
LCB	(ft-AP)	102.276F	----	112.426F
TCB	(ft-CL)	----	----	0.000
KMt	(ft)	16.939	----	13.697
FSc	(ft)	2.017	----	2.171
GMt	(ft)	2.245	----	-2.695
Shear Force	(LT)	----	----	----
Bending Moment	(ft-LT)	----	----	----

AFTER OUTFLOW CONDITION:
Displacement, KG, LCG, TCG include the effects of fluid outflow & flooding without free-communication
AS STRANDED CONDITION:
Displacement, KG, LCG, TCG include the effects of the flooded water at the equilibrium trim/heel.
Buoyancy, KB, LCB, TCB are for an intact hull at the equilibrium heel and drafts.
KMt is for the damaged hull at the upright flooded drafts.
F.S. correction accounts for the free surface of intact tanks and is corrected for outflow.

Figure L-4. Stranded Condition DWFWD800: Dewater FWD Focsle + Upper Peak + Er + Lift.

FREIGHTER -- WENDY (SINKING on 1989) OOC POSSE-SALV V1.00
Rev. 0 (by: GAP) 02-24-1993

FLUID OUTFLOW AFTER DAMAGE
DWFWD800: DEWATER FWD FOCSLE + UPPER PEAK + ER + LIFT

COMPARTMENT	FLUID OUTFLOW LTons	SP.VOL. ft3/LT	-------INTACT DATA BEFORE OUTFLOW------- % FULL	KG ft	LCG ft-AP	TCG ft-CL	FSc ft	Data Source
TANK1	40.6	35.0063	100.0	2.071	179.473F	0.000	0.018	Load Case
TANK2 STBD	30.2	35.0063	100.0	2.011	156.880F	7.188S	0.012	Load Case
TANK2 PORT	30.2	35.0063	100.0	2.011	156.880F	7.188P	0.012	Load Case
TANK3C	52.0	35.0063	100.0	1.944	128.050F	0.000	0.015	Load Case
TANK4S	0.8	39.0015	5.0	2.048	116.157F	11.330S	0.014	Load Case
TANK4P	0.8	39.0015	5.0	2.048	116.157F	11.330P	0.014	Load Case
TANK5C	13.1	35.8814	50.0	1.944	92.533F	0.000	0.010	Load Case
TOTALS	167.7						0.096	

Figure L-5. Fluid Outflow After Damage DWFWD800: Dewater FWD Focsle + Upper Peak + Er + Lift.

FLOODING AFTER DAMAGE
(For Equilibrium at 0.0o Heel)

COMPARTMENT	SEAWATER LTons	OIL LTons	PERM.	SP.VOL. ft3/LT	KG ft	LCG ft-AP	TCG ft-CL	FSc ft	SOUNDING ft	SPECIFIED % Full	PRESSURE PsiG
TANK1	40.6	----	0.99	35.0063	2.071	179.473F	0.000	0.000	[FREE]	---	
TANK2 STBD	30.2	----	0.98	35.0063	2.011	156.880F	7.188S	0.000	[FREE]	---	
TANK2 PORT	30.2	----	0.98	35.0063	2.011	156.880F	7.188P	0.000	[FREE]	---	
TANK3C	52.0	----	0.98	35.0063	1.944	128.050F	0.000	0.000	[FREE]	---	---
TANK4S	17.7	----	0.98	35.0063	2.048	116.157F	11.330S	0.000	[FREE]	---	---
TANK4P	17.7	----	0.98	35.0063	2.048	116.157F	11.330P	0.000	[FREE]	---	---
TANK5C	26.9	----	0.98	35.0063	1.944	92.533F	0.000	0.000	[FREE]	---	---
TOTALS	215.4	0.0			2.004	139.445F	0.000	0.000			

Figure L-6. Flooding After Damage (For Equilibrium at 0.0o Heel).

FREIGHTER -- WENDY (SINKING on 1989) OOC POSSE-SALV V1.00
Rev. 0 (by: GAP) 02-24-1993

TANK WEIGHT SUMMARY

Diesel Oil Tanks

TANK NAME	WEIGHT LTons	% Full	CAPACITY LTons	VOLUME bbls	NET VOL. bbls	API GRAV.	TEMP. oF	SP.VOL. bbls/LT	KG ft-BL	LCG ft-AP	TCG ft-CL	F.S. ft-LTons
TANK3P	6.5	26.7	24.3	45.2	45.2	----	60.0	6.9465	2.037	135.861F	11.337P	74.9
TANK3S	6.5	26.7	24.3	45.2	45.2	----	60.0	6.9465	2.037	135.861F	11.337S	74.9
TANK4P	0.8	5.0	15.9	5.5	5.5	----	60.0	6.9465	2.048	116.157F	11.330P	51.4
TANK4S	0.8	5.0	15.9	5.5	5.5	----	60.0	6.9465	2.048	116.157F	11.330S	51.4
SETTLING	3.0	50.0	6.0	20.8	20.8	----	60.0	6.9465	12.190	12.822F	0.000	38.6
TOTALS	17.6	20.3	86.4	122.1	122.1				3.764	113.152F	0.000	291.3

Fresh Water Tanks

TANK NAME	WEIGHT LTons	% Full	CAPACITY LTons	VOLUME ft3	SP.VOL. ft3/LT	KG ft-BL	LCG ft-AP	TCG ft-CL	F.S. ft LTons
TANK5C	13.1	50.0	26.2	470.6	35.8814	1.944	92.533F	0.000	35.0
TOTALS	13.1	50.0	26.2	470.6		1.944	92.533F	0.000	35.0

SW Ballast Tanks

TANK NAME	WEIGHT LTons	% Full	CAPACITY LTons	VOLUME ft3	SP.VOL. ft3/LT	KG ft-BL	LCG ft-AP	TCG ft-CL	F.S. ft-LTons
STEERING	0.0	0.0	63.5	0.0	35.0062	19.408	4.011F	0.000	0.0
AFTER PEAK	0.0	0.0	30.1	0.0	35.0062	11.589	6.641F	0.000	0.0
AFT HOLD	0.0	0.0	68.0	0.0	35.0062	19.321	11.432F	1.483S	0.0
MISC 1C	0.0	0.0	15.9	0.0	35.0062	19.132	18.715F	1.061S	0.0
ENGINE RM	0.0	0.0	353.0	0.0	35.0062	13.228	31.553F	0.600S	0.0
MISC 2P	28.9	100.0	28.9	1,012.4	35.0062	18.829	39.622F	12.071P	21.6
FORECASTLE	122.5	100.0	122.5	4,289.3	35.0062	27.822	200.248F	0.000	202.1
UPPER PEAK	35.5	100.0	35.5	1,244.5	35.0062	19.570	206.052F	0.004P	16.8
LOWER PEAK	13.8	100.0	13.8	482.4	35.0062	9.257	203.504F	0.000	5.8
TANK1	40.6	100.0	40.6	1,422.6	35.0062	2.071	179.473F	0.000	67.4
TANK2 PORT	30.2	100.0	30.2	1,057.2	35.0062	2.011	156.880F	7.188P	45.6
TANK2 STBD	30.2	100.0	30.2	1,057.2	35.0062	2.011	156.880F	7.188S	45.6
TANK3C	52.0	100.0	52.0	1,820.1	35.0062	1.944	128.050F	0.000	54.9
TANK5P	42.5	100.0	42.5	1,486.4	35.0062	2.033	92.718F	10.114P	51.6
TANK5S	42.5	100.0	42.5	1,486.4	35.0062	2.033	92.718F	10.114S	51.6
TANK6P	42.5	100.0	42.5	1,486.7	35.0062	2.037	62.677F	6.483P	62.5
TANK6S	42.5	100.0	42.5	1,486.7	35.0062	2.037	62.677F	6.483S	62.5
CARGO	2,458.6	100.0	2,458.6	86,065.2	35.0062	13.280	115.784F	0.000	6,375.1
TOTALS	2,982.2	84.9	3,512.8	104,396.9		12,768	119.742F	0.117P	7,063.1

Figure L-7a. Tank Weight Summary (sheet 1 of 2).

FREIGHTER -- WENDY (SINKING on 1989)
Rev. 0 (by: GAP)

OOC POSSE-SALV V1.00
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TANK WEIGHT SUMMARY

Constant

ITEM	WEIGHT LTons	KG ft-BL	LCG ft-AP	TCG ft-CL	F.S. ft-LTons
CEMENT SHAFT	5.6	2.986	5.624	0.000	1.5
TOTALS	5.6	2.986	5.624F	0.000	1.5

Figure L-7b. Tank Weight Summary (sheet 2 of 2).

FREIGHTER -- WENDY (SINKING on 1989)
Rev. 0 (by: GAP)

OOC POSSE-SALV V1.00
02-24-1993

CARGO SUMMARY

BulkIn Hold

	WEIGHT LTons	VCG ft-BL	LCG ft-AP	TCG ft-CL	VOLUME ft3	S.F. ft3/LT
PAPER	100.0	13.000	120.000F	0.000	9,999.0	99.9900
Totals	100.0	13.000	120.000F	0.000	9,999.0	99.9900

Figure L-8a. Cargo Summary (sheet 1 of 2).

FREIGHTER -- WENDY (SINKING on 1989)
Rev. 0 (by: GAP)

OOC POSSE-SALV V1.00
02-24-1993

CARGO SUMMARY

Misc. Weights

ITEM	WEIGHT LTons	KG ft-BL	LCG ft-AP	TCG ft-CL	F.S. ft-LTons	AFT BND ft-AP	FWD BND ft-AP
CHAIN 1	-70.0	23.000	200.000F	0.000	0.0	183.596F	216.404F
CHAIN 2	-40.0	1.000	184.000F	0.000	0.0	168.596F	201.404F
CHAIN 3	-70.0	1.000	168.000F	0.000	0.0	151.596F	184.404F
GRASP	-75.0	23.000	200.000F	0.000	0.0	183.596F	216.404F
TOTALS	-255.0	13.510	188.706F	0.000	0.0		

Figure L-8a. Cargo Summary (sheet 2 of 2).

APPENDIX M

PHASE V EXTRACTION BOW LIFT OF WENDY

The enclosed figures present the POSSE model for the configuration of WENDY during the heavy lift of her bow using the YC and extraction by the USS GRASP. Two sets of data are presented to show the effect of a difference in estimated aft draft of one foot.

In preparation for the lift, all compartments aft of and including the engine room were pumped dry. The YC was positioned over the centerline of the bow. Five sets of wire rope were slung under the bow. An estimated lift of 300 Ltons was expected to be provided by the YC by de-ballasting. Because the model wasn't known to be 100 percent accurate, the YFN was rigged aft to carry up to 120 tons of weight to ensure the stern would not go under.

The USS GRASP was rigged to de-beach the WENDY as the model indicated that a small ground reaction might still be present once the YC and YFN were fully de-ballasted. The GRASP was also rigged to tow the WENDY to sea once the extraction was completed.

While the YFN was still being secured to the stern of the WENDY, the final de-ballasting of the YC was in progress. With about 10 to 15 tons remaining to be pumped out of the YC it was observed that the WENDY was afloat.

FREIGHTER -- WENDY (SINKING on 1989) OOC POSSE-SALV V1.00
Rev. 0 (by: GAP) 02-24-1993

STRANDING on TWO PINNACLES
BOWLIFT

Damaged Compartments:

TANK1 TANK2 STBD TANK2 PORT TANK3C TANK4S TANK4P
TANK5C

	DISPLACEMENT LTons	DRAFT AFT ft	DRAFT FWD ft	TRIM ft	HEEL deg.	UPRIGHT GMt ft
INTACT	3,618.6	20.172	25.195	5.024F	3.74P	1.476
STRANDED	3,666.2	12.244	50.895	38.651F	0.00	-3.063

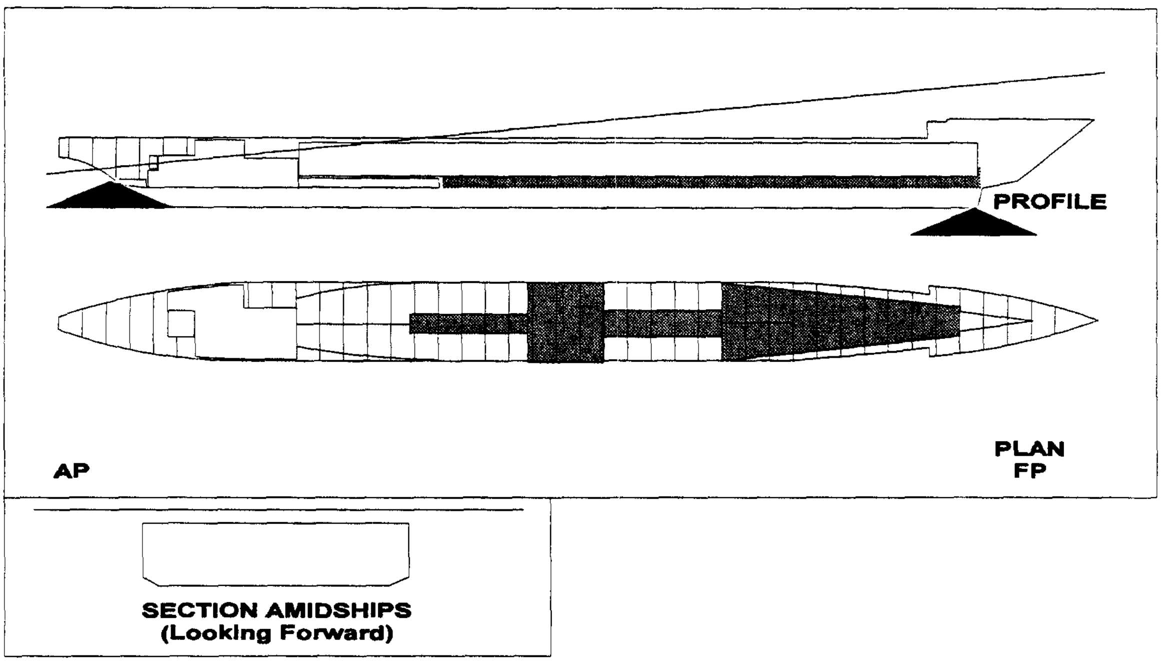

Figure M-1. Stranding on Two Pinnacles Bowlift.

FREIGHTER -- WENDY (SINKING on 1989) OOC POSSE-SALV V1.00
Rev. 0 (by: GAP) 02-24-1993

DAMAGE EVALUATION SUMMARY
BOWLIFT

Stranding Evaluation: (STRANDING on TWO PINNACLES)
Total Ground Reaction = 178.3 LTons Force to Free = 59.9 STons
Longl Center of Grd.R.= 5.698F ft-AP Bottom Type = Silt (Cf=0.30)

Summary of Breached Compartments:

BREACHED COMPARTMENTS	PERM.	FLOODED WATER LTons	% FULL (Intact)	SP.VOL. ft3/LT	OUTFLOW LTons
TANK1	0.990	40.6	100.0	35.0063	40.6
TANK2 STBD	0.980	30.2	100.0	35.0063	30.2
TANK2 PORT	0.980	30.2	100.0	35.0063	30.2
TANK3C	0.980	52.0	100.0	35.0063	52.0
TANK4S	0.980	17.7	5.0	39.0015	0.8
TANK4P	0.980	17.7	5.0	39.0015	0.8
TANK5C	0.980	26.9	50.0	35.8814	13.1
TOTALS		215.4			167.7

OIL OUTFLOW = 1.6 LTons

Figure M-2. Damage Evaluation Summary Bowlift.

```
FREIGHTER -- WENDY  (SINKING on 1989)                      OOC POSSE-SALV V1.00
Rev. 0  (by: GAP)                                                    02-24-1993

                         STRANDING on TWO PINNACLES
                                   BOWLIFT

 OBSERVED DATA
 Draft at A.P.                                  ---
 Draft at F.P.                                  ---
 Static Heel Angle                             0.000  deg

 Tidal Height                                  0.000  ft

 Specified Ground Contact              AFT PINNACLE        FWD PINNACLE
 ----------------------------------------------------------------------
 Longitudinal Location                    0.000  ft-AP    197.000F ft-AP
 Transverse Location                      0.000  ft-CL      0.000  ft-CL
 Depth of Water Over Ground               2.000  ft        47.000  ft
 ----------------------------------------------------------------------


 COMPUTED DATA
 Type of Ground Contact                   AFT PINNACLE       FWD PINNACLE
 ----------------------------------------------------------------------
 (R) Ground Reaction                      173.1  LTons         5.2  LTons
 (LCR) Long'l Ctr. of Grd. Reaction       0.000  ft-AP    197.000F ft-AP
 Water Depth at LCR                       2.000  ft        47.816  ft
 Ht of Contact Pt. abv. Baseline          0.000  ft         0.000  ft
 Aft Boundary of Ground Contact           0.500A ft-AP    196.500F ft-AP
 Fwd Boundary of Ground Contact           0.500F ft-AP    197.500F ft-AP
 (TCR) Transv. Ctr. of Grd. Reaction      1.959P ft-CL      1.959P ft-CL
 ----------------------------------------------------------------------
 Long'l Extent of Ground Contact          1.000  ft         1.000  ft
 Transv. Extent of Ground Contact         1.000  ft         1.000  ft
 Grounding Contact Area                   1.000  ft2        1.000  ft2
 Pressure on Hull                       173.127  LT/ft      5.157  LT/ft
 ----------------------------------------------------------------------

 Neutral Load Point          ---
   LBP                   214.050  ft
   LCF                    29.752F ft-AP
   Mt1in                     2.5  ft-LT/in
   TPI                      3.26  LT/in

 (F) Force to Free          59.9  ST
   Coef. of Friction        0.30
   Seafloor Type            SILT
```

Figure M-3. Stranding on Two Pinnacles Bowlift.

FREIGHTER -- WENDY (SINKING on 1989) OOC POSSE-SALV V1.00
Rev. 0 (by: GAP) 02-24-1993

STRANDED CONDITION
BOWLIFT

ITEM	WEIGHT LTons	KG ft-BL	LCG ft-AP	TCG ft-CL	FSmom ft-LTons
Light Ship	800.0	13.000	80.000F	0.000	
Constant	5.6	2.986	8.624F	0.000	1.5
Bulk Cargo	100.0	13.000	120.000F	0.000	
Misc. Weight	-300.0	5.400	173.000F	0.000	0.0
Diesel Oil	17.6	3.764	113.152F	0.000	291.3
Fresh Water	13.1	1.944	92.533F	0.000	35.0
SW Ballast	2,982.2	12.768	119.742F	0.117P	7,063.1
TOTALS	3,618.6	13.339	106.244F	0.097P	7,390.8

		INTACT	AFTER OUTFLOW	AS STRANDED
Draft at A.P.	(ft)	20.172	----	12.244
Draft at F.P.	(ft)	25.195	----	50.895
Trim	(ft)	5.024F	----	38.651F
Draft at Aft Marks	(ft)	20.172	----	12.244
Draft at Fwd Marks	(ft)	25.194	----	50.886
Static Heel Angle	(deg)	3.74P	----	0.00
Total Weight	(LT)	3,618.6	3,450.8	3,666.2
KG	(ft)	13.339	13.890	13.192
LCG	(ft-AP)	106.244F	104.214F	106.284F
TCG	(ft-CL)	0.097P	0.101P	0.095P
Buoyancy	(LT)	3,618.6	----	3,487.9
KB	(ft)	----	----	12.137
LCB	(ft-AP)	102.323F	----	111.738F
TCB	(ft-CL)	----	----	0.000
KMt	(ft)	16.857	----	13.735
FSc	(ft)	2.042	----	2.151
GMt	(ft)	1.476	----	-3.063
Shear Force	(LT)	----	----	----
Bending Moment	(ft-LT)	----	----	----

AFTER OUTFLOW CONDITION:
Displacement, KG, LCG, TCG include the effects of fluid outflow & flooding without free-communication.
AS STRANDED CONDITION:
Displacement, KG, LCG, TCG include the effects of the flooded water at the equilibrium trim/heel.
Buoyancy, KB, LCB, TCB are for an intact hull at the equilibrium heel and drafts.
KMt is for the damaged hull at the upright flooded drafts.
F.S. correction accounts for the free surface of intact tanks and is corrected for outflow.

Figure M-4. Stranded Condition Bowlift.

FREIGHTER -- WENDY (SINKING on 1989) OOC POSSE-SALV V1.00
Rev. 0 (by: GAP) 02-24-1993

FLUID OUTFLOW AFTER DAMAGE
BOWLIFT

COMPARTMENT	FLUID OUTFLOW LTons	SP.VOL. ft3/LT	------- INTACT DATA BEFORE OUTFLOW ------- % FULL	KG ft	LCG ft-AP	TCG ft-CL	FSc ft	Data Source
TANK1	40.6	35.0063	100.0	2.071	179.473F	0.000	0.019	Load Case
TANK2 STBD	30.2	35.0063	100.0	2.011	156.880F	7.188S	0.013	Load Case
TANK2 PORT	30.2	35.0063	100.0	2.011	156.880F	7.188P	0.013	Load Case
TANK3C	52.0	35.0063	100.0	1.944	128.050F	0.000	0.015	Load Case
TANK4S	0.8	39.0015	5.0	2.048	116.157F	11.330S	0.014	Load Case
TANK4P	0.8	39.0015	5.0	2.048	116.157F	11.330P	0.014	Load Case
TANK5C	13.1	35.8814	50.0	1.944	92.533F	0.000	0.010	Load Case
TOTALS	167.7						0.097	

Figure M-5. Fluid Outflow After Damage Bowlift.

FLOODING AFTER DAMAGE
(For Equilibrium at 0.0o Heel)

COMPARTMENT	SEAWATER LTons	OIL LTons	PERM.	SP.VOL. ft3/LT	KG ft	LCG ft-AP	TCG ft-CL	FSc ft	SOUNDING ft	SPECIFIED % Full	PRESSURE PsiG
TANK1	40.6	----	0.99	35.0063	2.071	179.473F	0.000	0.000	[FREE]	---	---
TANK2 STBD	30.2	----	0.98	35.0063	2.011	156.880F	7.188S	0.000	[FREE]	---	---
TANK2 PORT	30.2	----	0.98	35.0063	2.011	156.880F	7.188P	0.000	[FREE]	---	---
TANK3C	52.0	----	0.98	35.0063	1.944	128.050F	0.000	0.000	[FREE]	---	---
TANK4S	17.7	----	0.98	35.0063	2.048	116.157F	11.330S	0.000	[FREE]	---	---
TANK4P	17.7	----	0.98	35.0063	2.048	116.157F	11.330P	0.000	[FREE]	---	---
TANK5C	26.9	----	0.98	35.0063	1.944	92.533F	0.000	0.000	[FREE]	---	-
TOTALS	215.4	0.0			2.004	139.445F	0.000	0.000			

Figure M-6. Flooding After Damage (For Equilibrium at 0.0o Heel).

FREIGHTER -- WENDY (SINKING on 1989) OOC POSSE-SALV V1.00
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TANK WEIGHT SUMMARY

Diesel Oil Tanks

TANK NAME	WEIGHT LTons	% Full	CAPACITY LTons	VOLUME bbls	NET VOL. bbls	API GRAV.	TEMP. oF	SP.VOL. bbls/LT	KG ft-BL	LCG ft-AP	TCG ft-CL	F.S. ft-LTons
TANK3P	6.5	26.7	24.3	45.2	45.2	----	60.0	6.9465	2.037	135.861F	11.337P	74.9
TANK3S	6.5	26.7	24.3	45.2	45.2	----	60.0	6.9465	2.037	135.861F	11.337S	74.9
TANK4P	0.8	5.0	15.9	5.5	5.5	----	60.0	6.9465	2.048	116.157F	11.330P	51.4
TANK4S	0.8	5.0	15.9	5.5	5.5	----	60.0	6.9465	2.048	116.157F	11.330S	51.4
SETTLING	3.0	50.0	6.0	20.8	20.8	----	60.0	6.9465	12.190	12.822F	0.000	38.6
TOTALS	17.6	20.3	86.4	122.1	122.1				3.764	113.152F	0.000	291.3

Fresh Water Tanks

TANK NAME	WEIGHT LTons	% Full	CAPACITY LTons	VOLUME ft3	SP.VOL. ft3/LT	KG ft-BL	LCG ft-AP	TCG ft-CL	F.S. ft-LTons
TANK3C	13.1	50.0	26.2	470.6	35.8814	1.944	92.533F	0.000	35.0
TOTALS	13.1	50.0	26.2	470.6		1.944	92.533F	0.000	35.0

SW Ballast Tanks

TANK NAME	WEIGHT LTons	% Full	CAPACITY LTons	VOLUME ft3	SP.VOL. ft3/LT	KG ft-BL	LCG ft-AP	TCG ft-CL	F.S. ft LTons
STEERING	0.0	0.0	63.5	0.0	35.0062	19.408	4.011F	0.000	0.0
AFTER PEAK	0.0	0.0	30.1	0.0	35.0062	11.589	6.641F	0.000	0.0
AFT HOLD	0.0	0.0	68.0	0.0	35.0062	19.321	11.432F	1.483S	0.0
MISC 1C	0.0	0.0	15.9	0.0	35.0062	19.132	18.715F	1.061S	0.0
ENGINE RM	0.0	0.0	353.0	0.0	35.0062	13.228	31.553F	0.600S	0.0
MISC 2F	28.9	100.0	28.9	1,012.4	35.0062	18.829	39.622F	12.071P	2[illegible].6
FORECASTLE	122.5	100.0	122.5	4,289.3	35.0062	27.822	200.248F	0.000	202.1
UPPER PEAK	35.5	100.0	35.5	1,244.5	35.0062	19.570	206.052F	0.004P	16.8
LOWER PEAK	13.8	100.0	13.8	482.4	35.0062	9.257	203.504F	0.000	5.8
TANK1	40.6	100.0	40.6	1,422.6	35.0062	2.071	179.473F	0.000	67.4
TANK2 PORT	30.2	100.0	30.2	1,057.2	35.0062	2.011	156.880F	7.188P	45.6
TANK2 STBD	30.2	100.0	30.2	1,057.2	35.0062	2.011	156.880F	7.188S	45.6
TANK3C	52.0	100.0	52.0	1,820.1	35.0062	1.944	128.050F	0.000	54.9
TANK5P	42.5	100.0	42.5	1,486.4	35.0062	2.033	92.718F	10.114P	51.6
TANK5S	42.5	100.0	42.5	1,486.4	35.0062	2.033	92.718F	10.114S	51.6
TANK6P	42.5	100.0	42.5	1,486.7	35.0062	2.037	62.677F	6.483P	62.5
TANK6S	42.5	100.0	42.5	1,486.7	35.0062	2.037	62.677F	6.483S	62.5
CARGO	2,458.6	100.0	2,458.6	86,065.2	35.0062	13.280	115.784F	0.000	6,375.1
TOTALS	2,982.2	84.9	3,512.8	104,396.9		12.768	119.742F	0.117P	7,063.1

Figure M-7a. Tank Weight Summary (sheet 1 of 2).

FREIGHTER -- WENDY (SINKING on 1989) OOC POSSE-SALV V1.00
Rev. 0 (by: GAP) 02-24-1993

TANK WEIGHT SUMMARY

Constant

ITEM	WEIGHT LTons	KG ft-BL	LCG ft-AP	TCG ft-CL	F.S. ft-LTons
CEMENT SHAFT	5.6	2.986	8.624F	0.000	1.5
TOTALS	5.6	2.986	8.624F	0.000	1.5

Figure M-7b. Tank Weight Summary (sheet 2 of 2).

FREIGHTER -- WENDY (SINKING on 1989) OOC POSSE-SALV V1.00
Rev. 0 (by: GAP) 02-24-1993

CARGO SUMMARY

BulkIn Hold

	WEIGHT LTons	VCG ft-BL	LCG ft-AP	TCG ft-CL	VOLUME ft3	S.F. ft3/LT
PAPER	100.0	13.000	120.000F	0.000	9,999.0	99.9900
Totals	100.0	13.000	120.000F	0.000	9,999.0	99.9900

Figure M-8a. Cargo Summary (sheet 1 of 2).

FREIGHTER -- WENDY (SINKING on 1989) OOC POSSE-SALV V1.00
Rev. 0 (by: GAP) 02-24-1993

CARGO SUMMARY

Misc. Weights

ITEM	WEIGHT LTons	KG ft-BL	LCG ft-AP	TCG ft-CL	F.S. ft-LTons	AFT BND ft-AP	FWD BND ft-AP
CHAIN 1	-60.0	23.000	205.000F	0.000	0.0	204.900F	205.100F
CHAIN 2	-60.0	1.000	189.000F	0.000	0.0	188.900F	189.100F
CHAIN 3	-60.0	1.000	173.000F	0.000	0.0	172.900F	173.100F
CHAIN 4	-60.0	1.000	157.000F	0.000	0.0	156.900F	157.100F
CHAIN 5	-60.0	1.000	141.000F	0.000	0.0	140.900F	141.100F
TOTALS	-300.0	5.400	173.000F	0.000	0.0		

Figure M-8b. Cargo Summary (sheet 2 of 2).

FREIGHTER -- WENDY (SINKING on 1989) OOC POSSE-SALV V1.00
Rev. 0 (by: GAP) 02-24-1993

CARGO SUMMARY

Misc. Weights

ITEM	WEIGHT LTons	KG ft-BL	LCG ft-AP	TCG ft-CL	F.S. ft-LTons	AFT BND ft-AP	FWD BND ft-AP
CHAIN 1	-60.0	23.000	205.000F	0.000	0.0	204.900F	205.100F
CHAIN 2	-60.0	1.000	189.000F	0.000	0.0	188.900F	189.100F
CHAIN 3	-60.0	1.000	173.000F	0.000	0.0	172.900F	173.100F
CHAIN 4	-60.0	1.000	157.000F	0.000	0.0	156.900F	157.100F
CHAIN 5	-60.0	1.000	141.000F	0.000	0.0	140.900F	141.100F
TOTALS	-300.0	5.400	173.000F	0.000	0.0		

Figure M-9. Stranding on AFT Pinnacle Bowlift.

FREIGHTER -- WENDY (SINKING on 1989) OOC POSSE-SALV V1.00
Rev. 0 (by: GAP) 02-24-1993

DAMAGE EVALUATION SUMMARY
BOWLIFT

Stranding Evaluation: (STRANDING on AFT PINNACLE)
Total Ground Reaction = 43.3 LTons Force to Free = 14.6 STons
Longl Center of Grd.R.= 0.000 ft-AP Bottom Type = Silt (Cf=0.30)

Summary of Breached Compartments:

BREACHED COMPARTMENTS	PERM.	FLOODED WATER LTons	% FULL (Intact)	SP.VOL. ft3/LT	OUTFLOW LTons
TANK1	0.990	40.6	100.0	35.0063	40.6
TANK2 STBD	0.980	30.2	100.0	35.0063	30.2
TANK2 PORT	0.980	30.2	100.0	35.0063	30.2
TANK3C	0.980	52.0	100.0	35.0063	52.0
TANK4S	0.980	17.7	5.0	39.0015	0.8
TANK4P	0.980	17.7	5.0	39.0015	0.8
TANK5C	0.980	26.9	50.0	35.8814	13.1
TOTALS		215.4			167.7

OIL OUTFLOW = 1.6 LTons

Figure M-10. Damage Evaluation Summary Bowlift.

FREIGHTER -- WENDY (SINKING on 1989) OOC POSSE-SALV V1.00
Rev. 0 (by: GAP) 02-24-1993

STRANDED CONDITION
BOWLIFT

ITEM	WEIGHT LTons	KG ft-BL	LCG ft-AP	TCG ft-CL	FSmom ft-LTons
Light Ship	800.0	13.000	80.000F	0.000	
Constant	5.6	2.986	8.624F	0.000	1.5
Bulk Cargo	100.0	13.000	120.000F	0.000	
Misc. Weight	-300.0	5.400	173.000F	0.000	0.0
Diesel Oil	17.6	3.764	113.152F	0.000	291.3
Fresh Water	13.1	1.944	92.533F	0.000	35.0
SW Ballast	2,982.2	12.768	119.742F	0.117P	7,063.1
TOTALS	3,618.6	13.339	106.244F	0.097P	7,390.8

		INTACT	AFTER OUTFLOW	AS STRANDED
Draft at A.P.	(ft)	20.172	----	19.244
Draft at F.P.	(ft)	25.195	----	31.397
Trim	(ft)	5.024F	----	12.153F
Draft at Aft Marks	(ft)	20.172	----	19.244
Draft at Fwd Marks	(ft)	25.194	----	31.394
Static Heel Angle	(deg)	3.74P	----	0.00
Total Weight	(LT)	3,618.6	3,450.8	3,666.2
KG	(ft)	13.339	13.890	13.192
LCG	(ft-AP)	106.244F	104.214F	106.284F
TCG	(ft-CL)	0.097P	0.101P	0.095P
Buoyancy	(LT)	3,618.6	----	3,622.9
KB	(ft)	----	----	12.318
LCB	(ft-AP)	102.323F	----	107.620F
TCB	(ft-CL)	----	----	0.000
KMt	(ft)	16.857	----	14.300
FSc	(ft)	2.042	----	2.066
GMt	(ft)	1.476	----	-1.832
Shear Force	(LT)	----	----	----
Bending Moment	(ft-LT)	----	----	----

AFTER OUTFLOW CONDITION:
Displacement, KG, LCG, TCG include the effects of fluid outflow & flooding without free-communication.
AS STRANDED CONDITION:
Displacement, KG, LCG, TCG include the effects of the flooded water at the equilibrium trim/heel.
Buoyancy, KB, LCB, TCB are for an intact hull at the equilibrium heel and drafts.
KMt is for the damaged hull at the upright flooded drafts.
F.S. correction accounts for the free surface of intact tanks and is corrected for outflow.

Figure M-12. Stranded Condition Bowlift.

FREIGHTER -- WENDY (SINKING on 1989)　　　　OOC POSSE-SALV V1.00
Rev. 0 (by: GAP)　　　　02-24-1993

FLUID OUTFLOW AFTER DAMAGE
BOWLIFT

COMPARTMENT	FLUID OUTFLOW LTons	SP.VOL. ft3/LT	------- INTACT DATA BEFORE OUTFLOW ------- % FULL	KG ft	LCG ft-AP	TCG ft-CL	FSc ft	Data Source
TANK1	40.6	35.0063	100.0	2.071	179.473F	0.000	0.019	Load Case
TANK2 STBD	30.2	35.0063	100.0	2.011	156.880F	7.188S	0.013	Load Case
TANK2 PORT	30.2	35.0063	100.0	2.011	156.880F	7.188P	0.013	Load Case
TANK3C	52.0	35.0063	100.0	1.944	128.050F	0.000	0.015	Load Case
TANK4S	0.8	39.0015	5.0	2.048	116.157F	11.330S	0.014	Load Case
TANK4P	0.8	39.0015	5.0	2.048	116.157F	11.330P	0.014	Load Case
TANK5C	13.1	35.8814	50.0	1.944	92.533F	0.000	0.010	Load Case
TOTALS	167.7						0.097	

Figure M-13. Fluid Outflow After Damage Bowlift.

FLOODING AFTER DAMAGE
(For Equilibrium at 0.0o Heel)

COMPARTMENT	SEAWATER LTons	OIL LTons	PERM.	SP.VOL. ft3/LT	KG ft	LCG ft-AP	TCG ft-CL	FSc ft	SOUNDING ft	SPECIFIED % Full	PRESSURE PsiG
TANK1	40.6	----	0.99	35.0063	2.071	179.473F	0.000	0.000	[FREE]	---	---
TANK2 STBD	30.2	----	0.98	35.0063	2.011	156.880F	7.188S	0.000	[FREE]	---	---
TANK2 PORT	30.2	----	0.98	35.0063	2.011	156.880F	7.188P	0.000	[FREE]	---	---
TANK3C	52.0	----	0.98	35.0063	1.944	128.050F	0.000	0.000	[FREE]	---	---
TANK4S	17.7	----	0.98	35.0063	2.048	116.157F	11.330S	0.000	[FREE]	---	---
TANK4P	17.7	----	0.98	35.0063	2.048	116.157F	11.330P	0.000	[FREE]	---	---
TANK5C	26.9	----	0.98	35.0063	1.944	92.533F	0.000	0.000	[FREE]	---	---
TOTALS	215.4	0.0			2.004	139.445F	0.000	0.000			

Figure M-14. Flooding After Damage (For Equilibrium at 0.0o Heel).

FREIGHTER -- WENDY (SINKING on 1989) OOC POSSE-SALV V1.00
Rev. 0 (by: GAP) 02-24-1993

TANK WEIGHT SUMMARY

Diesel Oil Tanks

TANK NAME	WEIGHT LTons	% Full	CAPACITY LTons	VOLUME bbls	NET VOL. bbls	API GRAV.	TEMP. oF	SP.VOL. bbls/LT	KG ft-BL	LCG ft-AP	TCG ft-CL	F.S. ft-LTons
TANK3P	6.5	26.7	24.3	45.2	45.2	----	60.0	6.9465	2.037	135.861P	11.337P	74.9
TANK3S	6.5	26.7	24.3	45.2	45.2	----	60.0	6.9465	2.037	135.861F	11.337S	74.9
TANK4P	0.8	5.0	15.9	5.5	5.5	----	60.0	6.9465	2.048	116.157F	11.330P	51.4
TANK4S	0.8	5.0	15.9	5.5	5.5	----	60.0	6.9465	2.048	116.157F	11.330S	51.4
SETTLING	3.0	50.0	6.0	20.8	20.8	----	60.0	6.9465	12.190	12.822F	0.000	38.6
TOTALS	17.6	20.3	86.4	122.1	122.1				3.764	113.152F	0.000	291.3

Fresh Water Tanks

TANK NAME	WEIGHT LTons	% Full	CAPACITY LTons	VOLUME ft3	SP.VOL. ft3/LT	KG ft-BL	LCG ft-AP	TCG ft-CL	F.S. ft-LTons
TANK5C	13.1	50.0	26.2	470.6	35.8814	1.944	92.533F	0.000	35.0
TOTALS	13.1	50.0	26.2	470.6		1.944	92.533F	0.000	35.0

SW Ballast Tanks

TANK NAME	WEIGHT LTons	% Full	CAPACITY LTons	VOLUME ft3	SP.VOL. ft3/LT	KG ft-BL	LCG ft-AP	TCG ft-CL	F.S. ft-LTons
STEERING	0.0	0.0	63.5	0.0	35.0062	19.408	4.011F	0.000	0.0
AFTER PEAK	0.0	0.0	30.1	0.0	35.0062	11.589	6.641F	0.000	0.0
AFT HOLD	0.0	0.0	68.0	0.0	35.0062	19.321	11.432F	1.483S	0.0
MISC 1C	0.0	0.0	15.9	0.0	35.0062	19.132	18.715F	1.061S	0.0
ENGINE RM	0.0	0.0	353.0	0.0	35.0062	13.228	31.553F	0.600S	0.0
MISC 2P	28.9	100.0	28.9	1,012.4	35.0062	18.829	39.622F	12.071P	21.6
FORECASTLE	122.5	100.0	122.5	4,289.3	35.0062	27.822	200.248F	0.000	202.1
UPPER PEAK	35.5	100.0	35.5	1,244.5	35.0062	19.570	206.052F	0.004P	16.8
LOWER PEAK	13.8	100.0	13.8	482.4	35.0062	9.257	203.504F	0.000	5.8
TANK1	40.6	100.0	40.6	1,422.6	35.0062	2.071	179.473F	0.000	67.4
TANK2 PORT	30.2	100.0	30.2	1,057.2	35.0062	2.011	156.880F	7.188P	45.6
TANK2 STBD	30.2	100.0	30.2	1,057.2	35.0062	2.011	156.880F	7.188S	45.6
TANK3C	52.0	100.0	52.0	1,820.1	35.0062	1.944	128.050F	0.000	54.9
TANK5P	42.5	100.0	42.5	1,486.4	35.0062	2.033	92.718F	10.114P	51.6
TANK5S	42.5	100.0	42.5	1,486.4	35.0062	2.033	92.718F	10.114S	51.6
TANK6P	42.5	100.0	42.5	1,486.7	35.0062	2.037	62.677F	6.483P	62.5
TANK6S	42.5	100.0	42.5	1,486.7	35.0062	2.037	62.677F	6.483S	62.5
CARGO	2,458.6	100.0	2,458.6	86,065.2	35.0062	13.280	115.784F	0.000	6,375.1
TOTALS	2,982.2	84.9	3,512.8	104,396.9		12,768	119.742F	0.117P	7,063.1

Figure M-15a. Tank Weight Summary (sheet 1 of 2).

FREIGHTER -- WENDY (SINKING on 1989) OOC POSSE-SALV V1.00
Rev. 0 (by: GAP) 02-24-1993

TANK WEIGHT SUMMARY

Constant

ITEM	WEIGHT LTons	KG ft-BL	LCG ft-AP	TCG ft-CL	F.S. ft-LTons
CEMENT SHAFT	5.6	2.986	8.624F	0.000	1.5
TOTALS	5.6	2.986	8.624F	0.000	1.5

Figure M-15b. Tank Weight Summary (sheet 2 of 2).

FREIGHTER -- WENDY (SINKING on 1989) OOC POSSE-SALV V1.00
Rev. 0 (by: GAP) 02-24-1993

CARGO SUMMARY

BulkIn Hold

	WEIGHT LTons	VCG ft-BL	LCG ft-AP	TCG ft-CL	VOLUME ft3	S.F. ft3/LT
PAPER	100.0	13.000	120.000F	0.000	9,999.0	99.9900
Totals	100.0	13.000	120.000F	0.000	9,999.0	99.9900

Figure M-16a. Cargo Summary (sheet 1 of 2).

FREIGHTER -- WENDY (SINKING on 1989) OOC POSSE-SALV V1.00
Rev. 0 (by: GAP) 02-24-1993

CARGO SUMMARY

Misc. Weights

ITEM	WEIGHT LTons	KG ft-BL	LCG ft-AP	TCG ft-CL	F.S. ft-LTons	AFT BND ft-AP	FWD BND ft-AP
CHAIN 1	-60.0	23.000	205.000F	0.000	0.0	204.900F	205.100F
CHAIN 2	-60.0	1.000	189.000F	0.000	0.0	188.900F	189.100F
CHAIN 3	-60.0	1.000	173.000F	0.000	0.0	172.900F	173.100F
CHAIN 4	-60.0	1.000	157.000F	0.000	0.0	156.900F	157.100F
CHAIN 5	-60.0	1.000	141.000F	0.000	0.0	140.900F	141.100F
TOTALS	-300.0	5.400	173.000F	0.000	0.0		

Figure M-16b. Cargo Summary (sheet 2 of 2).

APPENDIX N

YFN BARGE DATA

The enclosed figures present the POSSE model for the configuration of the YFN. The YC had a height of 9 feet instead of 12 feet but had the same dead weight load capability of 550 Ltons.

YFN
Rev. 0 (by: GAP)

OOC POSSE-HINPUT V1.00
01-17-1993

YFN
HULL OFFSETS

General Information

```
Units          =   2   (ft:L.Tons)
Long'l Ref.    =   3   (F.P.)
Integ. Rule    =   1   (Simpson's)

LBP    =  110.000 ft
BEAM   =   32.000 ft
DEPTH  =   12.000 ft

Keel Thickness       =  0.500 in

Appendage Allowance = 0.0050 x Displacement
```

Profile Offsets

	LOCATION ft-FP	HEIGHT ft		LOCATION ft-FP	HEIGHT ft		LOCATION ft-FP	HEIGHT ft		LOCATION ft-FP	HEIGHT ft
1	110.00A	10.33	4	22.00A	0.00	7	0.00	12.00			
2	92.00A	2.00	5	18.00A	2.00	8	110.00A	12.00			
3	88.00A	0.00	6	0.00	10.33	9	110.00A	10.33			

Plan Offsets

	LOCATION ft-FP	H-BRTH ft		LOCATION ft-FP	H-BRTH ft		LOCATION ft-FP	H-BRTH ft		LOCATION ft-FP	H-BRTH ft
1	110.00A	16.00S	3	0.00	16.00P	5	110.00A	16.00S			
2	0.00	16.00S	4	110.00A	16.00P						

Figure N-1. YFN Hull Offsets.

YFN
Rev. 0 (by: GAP)

OOC POSSE-HINPUT V1.00
01-17-1993

YFN
HULL OFFSETS

No. 1 (X= 0.00 ft-FP) [symmetrical]

	HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft
1	10.33	0.00	3	10.33	16.00C1	5	12.00	0.00			
2	10.33	15.90C0	4	11.75	16.00C2						

No. 2 (X= 18.00A ft-FP) [symmetrical]

	HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft
1	2.00	0.00	3	2.29	15.71*	5	11.75	16.00C2			
2	2.00	15.00C0	4	3.00	16.00C1	6	12.00	0.00			

No. 3 (X= 22.00A ft-FP) [symmetrical]

	HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft
1	0.00	0.00	3	0.29	15.71*	5	11.75	16.00C2			
2	0.00	15.00C0	4	1.00	16.00C1	6	12.00	0.00			

No. 4 (X= 23.00A ft-FP) [symmetrical]

	HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft
1	0.00	0.00	3	0.29	15.71*	5	11.75	16.00C2			
2	0.00	15.00C0	4	1.00	16.00C1	6	12.00	0.00			

No. 5 (X= 39.00A ft-FP) [symmetrical]

	HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft
1	0.00	0.00	3	0.29	15.71*	5	11.75	16.00C2			
2	0.00	15.00C0	4	1.00	16.00C1	6	12.00	0.00			

No. 6 (X= 55.00A ft-FP) [symmetrical]

	HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft
1	0.00	0.00	3	0.29	15.71*	5	11.75	16.00C2			
2	0.00	15.00C0	4	1.00	16.00C1	6	12.00	0.00			

No. 7 (X= 71.00A ft-FP) [symmetrical]

	HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft
1	0.00	0.00	3	0.29	15.71*	5	11.75	16.00C2			
2	0.00	15.00C0	4	1.00	16.00C1	6	12.00	0.00			

No. 8 (X= 87.00A ft-FP) [symmetrical]

	HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft
1	0.00	0.00	3	0.29	15.71*	5	11.75	16.00C2			
2	0.00	15.00C0	4	1.00	16.00C1	6	12.00	0.00			

Figure N-2. YFN Hull Offsets (sheet 1 of 2).

YFN
Rev. 0 (by: GAP)

OOC POSSE-HINPUT V1.00
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YFN
HULL OFFSETS

	HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft		HEIGHT ft	H-BRTH ft
No. 9 (X= 88.00A ft-FP) [symmetrical]											
1	0.00	0.00	3	0.29	15.71*	5	11.75	16.00C2			
2	0.00	15.00CC	4	1.00	16.00C1	6	12.00	0.00			
No. 10 (X= 92.00A ft-FP) [symmetrical]											
1	2.00	0.00	3	2.29	15.71*	5	11.75	16.00C2			
2	2.00	15.00C0	4	3.00	16.00C1	6	12.00	0.00			
No. 11 (X= 110.00A ft-FP) [symmetrical]											
1	10.33	0.00	3	10.33	16.00C1	5	12.00	0.00			
2	10.33	15.90C0	4	11.75	16.00C2						

Figure N-2. YFN Hull Offsets (sheet 2 of 2).

YFN
Rev. 0 (by: GAP)

OOC POSSE-HINPUT V1.00
01-17-1993

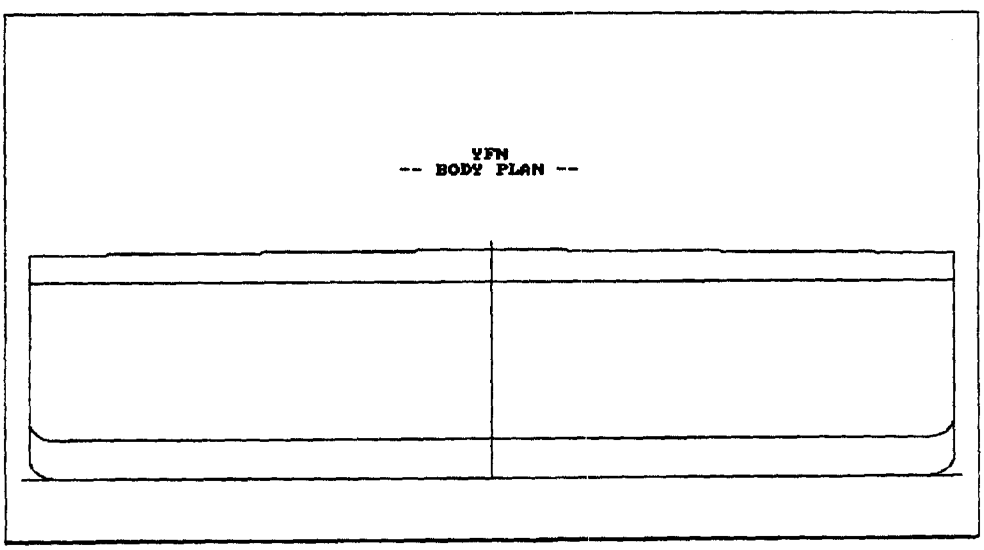


Figure N-3. YFN Body Plan.

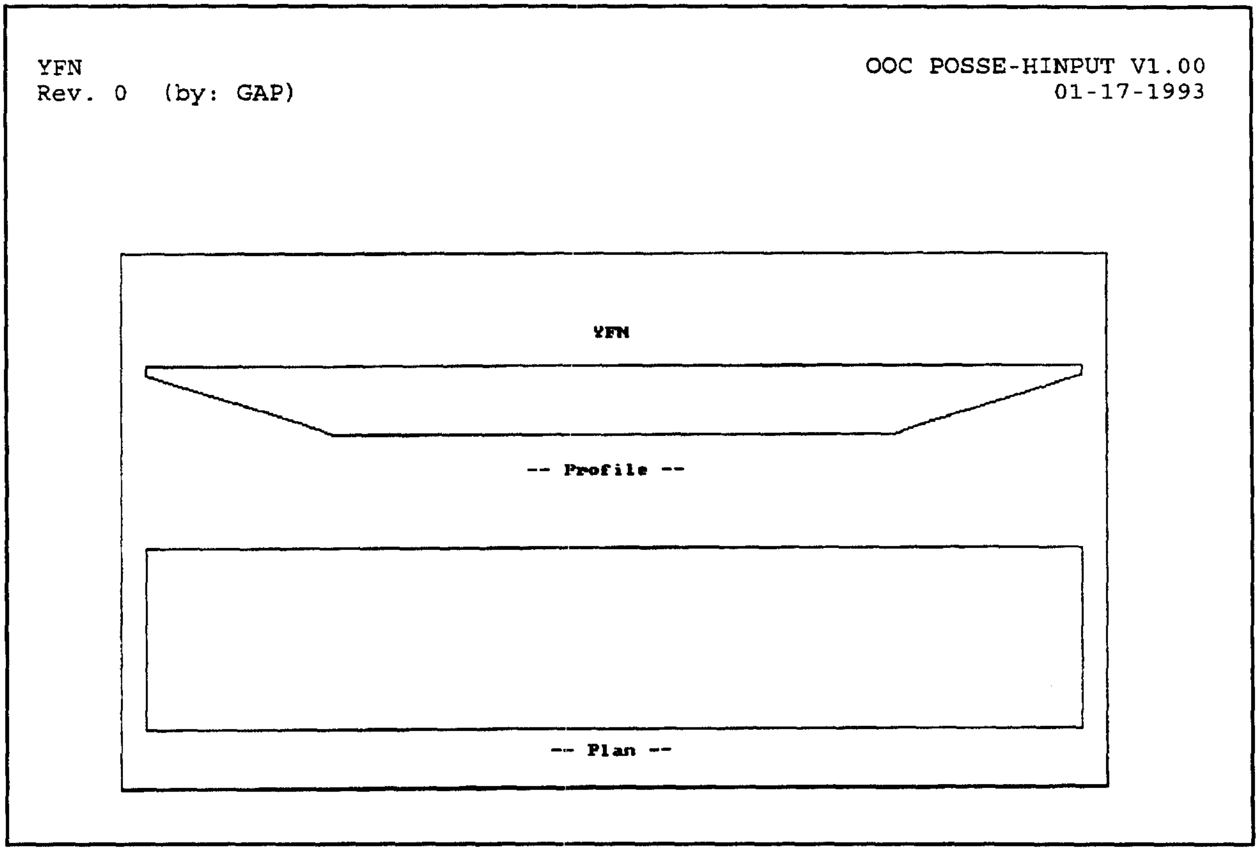


Figure N-4. YFN Profile Plan.

YFN -- YFN (HEAVY LIFT) OOC POSSE-HYDRO V1.00
Rev. 0 (by: GAP) 01-17-1993

HYDROSTATIC TABLES
YFN

MLD. DRAFT (ft)	DISPL. (LT-SW)	KMt (ft)	LCB (ft-FP)	LCF (ft-FP)	MT1in (ft-LT/in)	TPI (LT/in)
1.200	75	72.50	55.00A	55.00A	18.9	5.3
1.600	102	54.58	55.00A	55.00A	19.8	5.3
2.000	130	43.95	55.00A	55.00A	20.6	5.4
2.400	157	38.27	55.00A	55.00A	24.2	5.7
2.800	185	33.08	55.00A	55.00A	25.1	5.8
3.200	214	29.20	55.00A	55.00A	26.0	5.8
3.600	244	26.22	55.00A	55.00A	26.9	5.9
4.000	274	23.88	55.00A	55.00A	27.8	6.0
4.400	304	22.00	55.00A	55.00A	28.8	6.0
4.800	336	20.47	55.00A	55.00A	29.8	6.1
5.200	368	19.21	55.00A	55.00A	30.8	6.2
5.600	400	18.16	55.00A	55.00A	31.8	6.2
6.000	433	17.27	55.00A	55.00A	32.9	6.3
6.400	467	16.53	55.00A	55.00A	34.0	6.4
6.800	502	15.90	55.00A	55.00A	35.2	6.4
7.200	537	15.36	55.00A	55.00A	36.4	6.5
7.600	573	14.90	55.00A	55.00A	37.6	6.6
8.000	609	14.51	55.00A	55.00A	38.8	6.6
8.400	646	14.18	55.00A	55.00A	40.1	6.7
8.800	684	13.89	55.00A	55.00A	41.4	6.8
9.200	722	13.65	55.00A	55.00A	42.7	6.8
9.600	761	13.45	55.00A	55.00A	44.1	6.9
10.000	800	13.28	55.00A	55.00A	45.5	7.0
10.400	841	15.89	55.00A	55.00A	76.8	8.4
10.800	881	15.65	55.00A	55.00A	76.8	8.4
11.200	921	15.44	55.00A	55.00A	76.8	8.4
11.600	962	15.27	55.00A	55.00A	76.8	8.4
12.000	990	6.46	55.00A	55.00A	0.0	0.0

Assumes: Sea Water at 35.0063 ft3/LT
Ship floating at even keel (no heel or trim)

Figure N-5. Hydrostatic Tables YFN.

APPENDIX O

YFN BARGE STABILITY WITH SIDE LOAD

The enclosed figures present the stability data from the POSSE model for the configuration of the YFN. The first set analyzes the YFN with a side load on one side only and ballasted. The second set presents the YFN configuration as used for the heavy bow lift attempts. These calculations were used to estimate the maximum side loading that the barge could have and remain stable.

```
YFN -- YFN  (HEAVY LIFT)                                  OOC POSSE-LOAD V1.00
Rev. 0  (by: GAP)                                                   01-17-1993

                          TRIM & STABILITY SUMMARY


                     WEIGHT     KG       LCG      TCG        FSmom
 ITEM                LTons     ft-BL    ft-FP    ft-CL     ft-LTons
---------------------------------------------------------------------
 Light Ship            110      6.00    55.00A    0.00
 Constant                0      0.00    55.00A    0.00             0

 Misc. Weight          120     12.00    55.00A   16.00S            0

 SW Ballast            343      5.95    55.00A    0.00           886
---------------------------------------------------------------------
 TOTALS                573      7.23    55.00A    3.35S          886


 STABILITY CALCULATION                 TRIM CALCULATION
  KMt               14.89 ft            LCF Draft            7.61 ft
  KG                 7.23 ft            LCB (even keel)     55.00 ft-AFT
  GMt                7.67 ft            LCF                 55.00 ft-AFT
  FSc                1.55 ft            MT1in                  38 ft-LT/in
  GMt  Corrected     6.12 ft            Trim                 0.00 ft

                                        List                  >10 deg-STBD

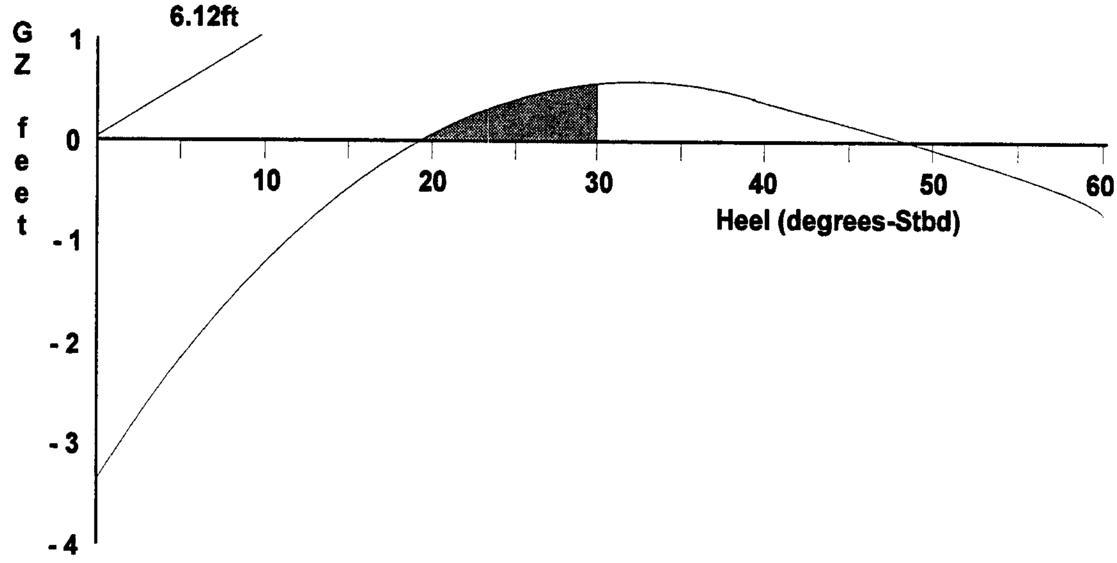

 DRAFTS
   F.P.   7ft- 7.3in ( 2.32m)             Fwd Marks  7ft- 7.3in ( 2.32m)
   M.S.   7ft- 7.3in ( 2.32m)             M.S.Marks  7ft- 7.3in ( 2.32m)
   A.P.   7ft- 7.3in ( 2.32m)             Aft Marks  7ft- 7.3in ( 2.32m)
```

Figure O-1. Trim & Stability Summary.

YFN -- YFN (HEAVY LIFT)
Rev. 0 (by: GAP)

OOC POSSE-LOAD V1.00
01-17-1993

STATICAL STABILITY



Angle of Heel	19.5 deg-S
Angle at Maximum GZ	30.8 deg
Area to 30.8 degrees	4.11 ft-deg
Maximum GZ	0.54 ft

Figure O-2. Statical Stability.

YFN -- YFN (HEAVY LIFT) OOC POSSE-LOAD V1.00
Rev. 0 (by: GAP) 01-17-1993

TANK WEIGHT SUMMARY

SW Ballast Tanks

TANK NAME	WEIGHT LTons	% Full	CAPACITY LTons	VOLUME ft3	SP.VOL. ft3/LT	KG ft-BL	LCG ft-FP	TCG ft-CL	F.S. ft-LTons
TANK1	0	0.0	144	0	35.0062	7.71	14.51A	0.00	0
TANK2	172	100.0	172	6,006	35.0062	5.95	31.00A	0.00	443
TANK3	0	0.0	172	0	35.0062	5.95	47.00A	0.00	0
TANK4	0	0.0	172	0	35.0062	5.95	63.00A	0.00	0
TANK5	172	100.0	172	6,006	35.0062	5.95	79.00A	0.00	443
TANK6	0	0.0	143	0	35.0062	7.74	95.51A	0.00	0
TOTALS	343	35.3	975	12,013		5.95	55.00A	0.00	886

Figure O-3. Tank Weight Summary.

YFN -- YFN (HEAVY LIFT) OOC POSSE-LOAD V1.00
Rev. 0 (by: GAP) 01-17-1993

CARGO SUMMARY

Misc. Weights

ITEM	WEIGHT LTons	KG ft-BL	LCG ft-FP	TCG ft-CL	F.S. ft-LTons	FWD BND ft-FP	AFT BND ft-FP
CHAIN 1	60	12.00	23.00A	16.00S	0	22.90A	23.10A
CHAIN 2	60	12.00	87.00A	16.00S	0	86.90A	87.10A
TOTALS	120	12.00	55.00A	16.00S	0		

Figure O-4. Cargo Summary.

YFN -- YFN (HEAVY LIFT)
Rev. 0 (by: GAP)

OOC POSSE-LOAD V1.00
01-17-1993

TRIM & STABILITY SUMMARY

ITEM	WEIGHT LTons	KG ft-BL	LCG ft-FP	TCG ft-CL	FSmom ft-LTons
Light Ship	110	6.00	55.00A	0.00	
Constant	0	0.00	55.00A	0.00	0
Misc. Weight	130	12.00	39.00A	8.62S	0
SW Ballast	0	0.00	55.00A	0.00	0
TOTALS	240	9.25	46.33A	4.67S	0

STABILITY CALCULATION

KMt	26.58 ft
KG	9.25 ft
GMt	17.33 ft
FSc	0.00 ft
GMt Corrected	17.33 ft

TRIM CALCULATION

LCF Draft	3.55 ft
LCB (even keel)	55.00 ft-AFT
LCF	55.00 ft-AFT
MT1in	27 ft-LT/in
Trim	6.48 ft-FWD
List	>10 deg-STBD

DRAFTS

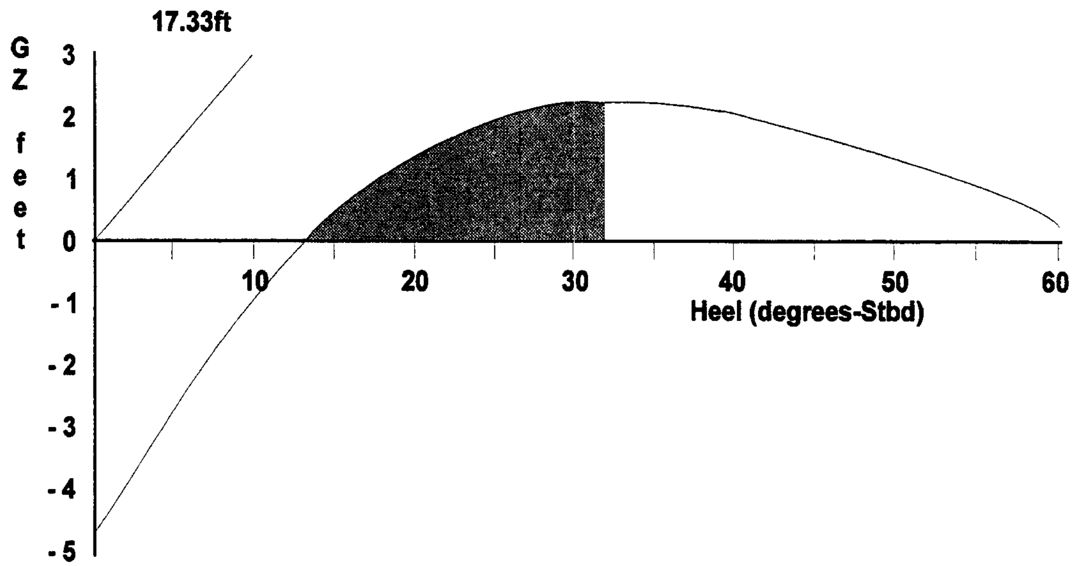
F.P.	6ft- 9.5in (2.07m)	Fwd Marks	5ft- 5.2in (1.66m)
M.S.	3ft- 6.6in (1.08m)	M.S.Marks	3ft- 6.6in (1.08m)
A.P.	0ft- 3.8in (0.10m)	Aft Marks	1ft- 8.0in (0.51m)

Figure O-5. Trim & Stability Summary.

YFN -- YFN (HEAVY LIFT)
Rev. 0 (by: GAP)

OOC POSSE-LOAD V1.00
01-17-1993

STATICAL STABILITY



Angle of Heel	13.2 deg-S
Angle at Maximum GZ	32.3 deg
Area to 32.3 degrees	29.31 ft-deg
Maximum GZ	2.20 ft

Figure O-6. Statical Stability.

YFN -- YFN (HEAVY LIFT) OOC POSSE-LOAD V1.00
Rev. 0 (by: GAP) 01-17-1993

TANK WEIGHT SUMMARY

SW Ballast Tanks

TANK NAME	WEIGHT LTons	% Full	CAPACITY LTons	VOLUME ft3	SP.VOL. ft3/LT	KG ft-BL	LCG ft-FP	TCG ft-CL	F.S. ft-LTons
TANK1	0	0.0	144	0	35.0062	7.71	14.51A	0.00	0
TANK2	0	0.0	172	0	35.0062	5.95	31.00A	0.00	0
TANK3	0	0.0	172	0	35.0062	5.95	47.00A	0.00	0
TANK4	0	0.0	172	0	35.0062	5.95	63.00A	0.00	0
TANK5	0	0.0	172	0	35.0062	5.95	79.00A	0.00	0
TANK6	0	0.0	143	0	35.0062	7.74	95.51A	0.00	0
TOTALS	0	0.0	975	0					

Figure O-7. Tank Weight Summary.

YFN -- YFN (HEAVY LIFT) OOC POSSE-LOAD V1.00
Rev. 0 (by: GAP) 01-17-1993

CARGO SUMMARY

Misc. Weights

ITEM	WEIGHT LTons	KG ft-BL	LCG ft-FP	TCG ft-CL	F.S. ft-LTons	FWD BND ft-FP	AFT BND ft-FP
CHAIN 1	50	12.00	23.00A	16.00S	0	22.90A	23.10A
CHAIN 2	30	12.00	39.00A	16.00P	0	38.90A	39.10A
CHAIN 3	50	12.00	55.00A	16.00S	0	54.90A	55.10A
TOTALS	130	12.00	39.00A	8.62S	0		

Figure O-8. Cargo Summary.

APPENDIX P

YFN BARGE STABILITY WITH END LOAD

The enclosed figures present the stability data from the POSSE model for the configuration of the YFN. This configuration represents the YFN configuration as used for the heavy bow lift attempts with the YFN attempting a solo lift of the bow. These calculations were used to estimate the maximum end loading that the barge could have and remain stable.

YFN -- YFN

OOC POSSE-LOAD V1.00

TRIM & STABILITY SUMMARY

ITEM	WEIGHT LTons	KG ft-BL	LCG ft-FP	TCG ft-CL	FSmom ft-LTons
Light Ship	110.0	6.00	55.00A	0.00	
Constant	0.0	0.00	55.00A	0.00	0.0
Misc. Weight	143.0	13.37	85.00A	0.00	0.0
SW Ballast	130.0	5.95	79.00A	0.00	1,248.1
TOTALS	383.0	8.73	74.35A	0.00	1,248.1

STABILITY CALCULATION

KMt	18.71 ft
KG	8.73 ft
GMt	9.97 ft
FSc	3.26 ft
GMt Corrected	6.71 ft

TRIM CALCULATION

LCF Draft	5.39 ft
LCB (even keel)	55.00 ft-AFT
LCF	55.00 ft-AFT
MT1in	31 ft-LT/in
Trim	19.73 ft-AFT
List	0.00 deg

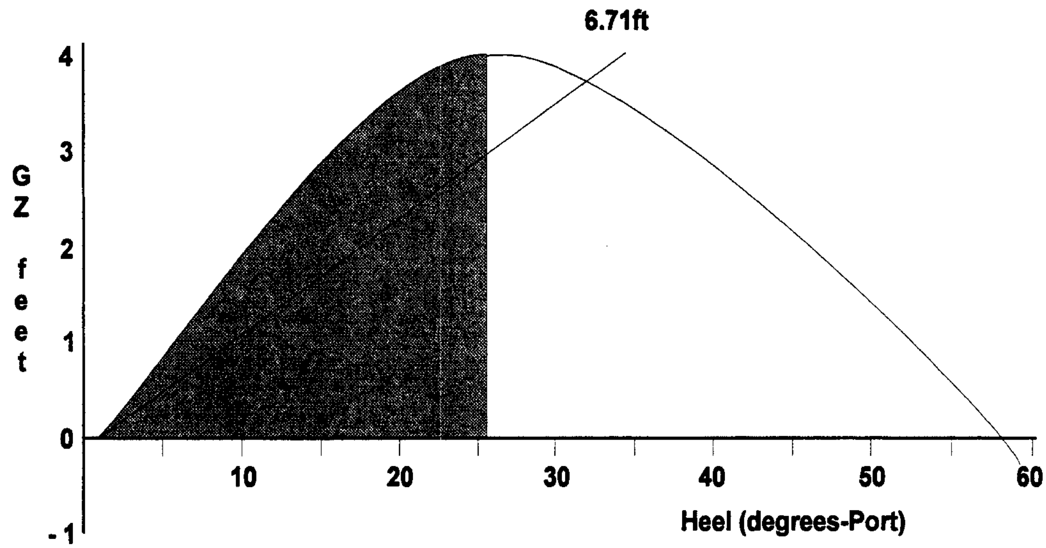
DRAFTS

F.P.	-4ft--5.71in (-1.364m)	Fwd Marks	0ft--4.20in (-0.107m)
M.S.	5ft- 4.69in (1.643m)	M.S.Marks	5ft- 4.69in (1.643m)
A.P.	15ft- 3.08in (4.650m)	Aft Marks	11ft- 1.57in (3.393m)

Figure P-1. Trim & Stability Summary.

YFN -- YFN   OOC POSSE-LOAD V1.00

STATICAL STABILITY



Angle of Heel	0.00 deg
Angle at Maximum GZ	25.50 deg
Area to 25.50 degrees	58.879 ft-deg
Maximum GZ	3.99 ft

Figure P-2. Statical Stability

YFN -- YFN OOC POSSE-LOAD V1.00

TANK WEIGHT SUMMARY

SW Ballast Tanks

TANK NAME	WEIGHT LTons	% Full	CAPACITY LTons	VOLUME ft3	SP.VOL. ft3/LT	KG ft-BL	LCG ft-FP	TCG ft-CL	F.S. ft-LTons
TANK1	0.0	0.0	143.8	0.0	35.0062	7.71	14.51A	0.00	0.0
TANK2	0.0	0.0	171.6	0.0	35.0062	5.95	31.00A	0.00	0.0
TANK3	0.0	0.0	171.6	0.0	35.0062	5.95	47.00A	0.00	0.0
TANK4	0.0	0.0	171.6	0.0	35.0062	5.95	63.00A	0.00	0.0
TANK5	130.0	75.9	171.6	4,550.8	35.0062	5.95	79.00A	0.00	1,248.1
TANK6	0.0	0.0	143.1	0.0	35.0062	7.74	95.51A	0.00	0.0
TOTALS	130.0	13.4	973.3	4,550.8		5.95	79.00A	0.00	1,248.1

Figure P-3. Tank Weight Summary.

YFN -- YFN OOC POSSE-LOAD V1.00

CARGO SUMMARY

Misc. Weights

ITEM	WEIGHT LTons	KG ft-BL	LCG ft-FP	TCG ft-CL	F.S. ft-LTons	FWD BND ft-FP	AFT BND ft-FP
CRANE	15.0	16.00	85.00A	0.00	0.0	72.00A	97.00A
MISC	8.0	14.00	55.00A	0.00	0.0	10.00A	100.00A
LIFT	120.0	13.00	87.00A	0.00	0.0	86.50A	87.50A
TOTALS	143.0	13.37	85.00A	0.00	0.0		

Figure P-4. Cargo Summary.

APPENDIX Q

DAMAGE CONTROL PLANS FOR WENDY

The enclosed drawings were derived from the damage control plans for the M/V WENDY. The original drawings were provided by the Honduran Government during the trip to Honduras to brief the president on the intended salvage plan.

The original drawings were the major source of information which provided the hull form and the compartment layout. Several compartments were modified in the stern area based upon initial diver surveys because the exact layout could not be determined from these damage control plans.

NOTE:
Drawings not to scale.
Derived from poor quality
original. DC plates provided
by Honduran government.

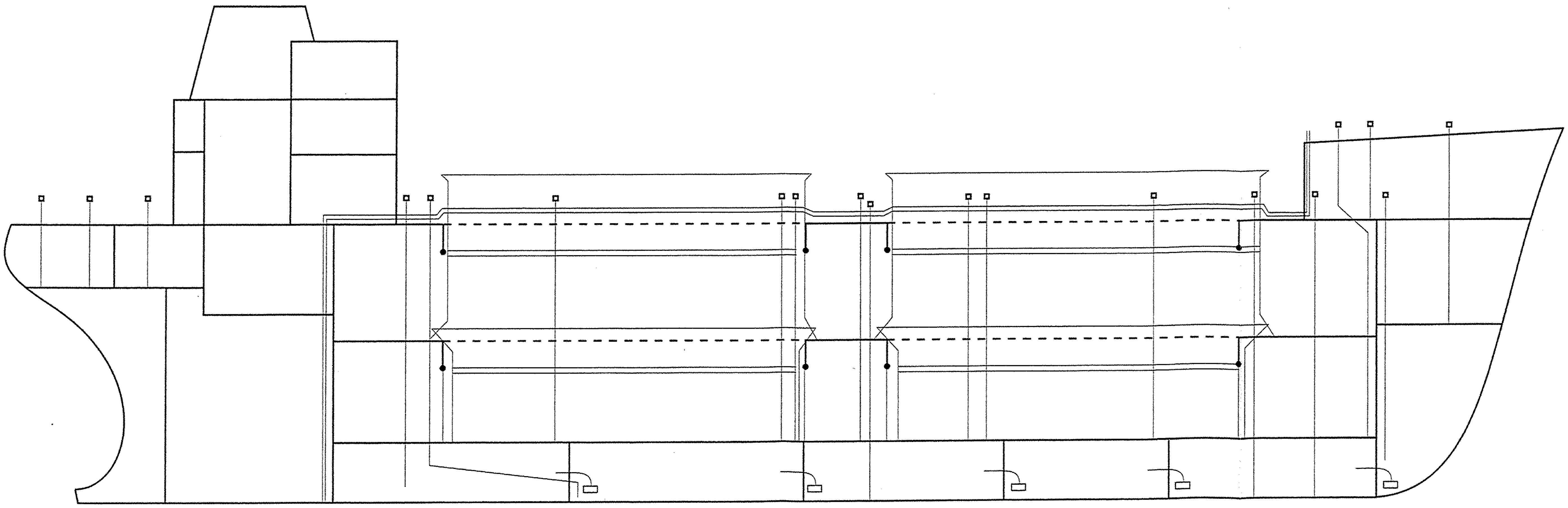
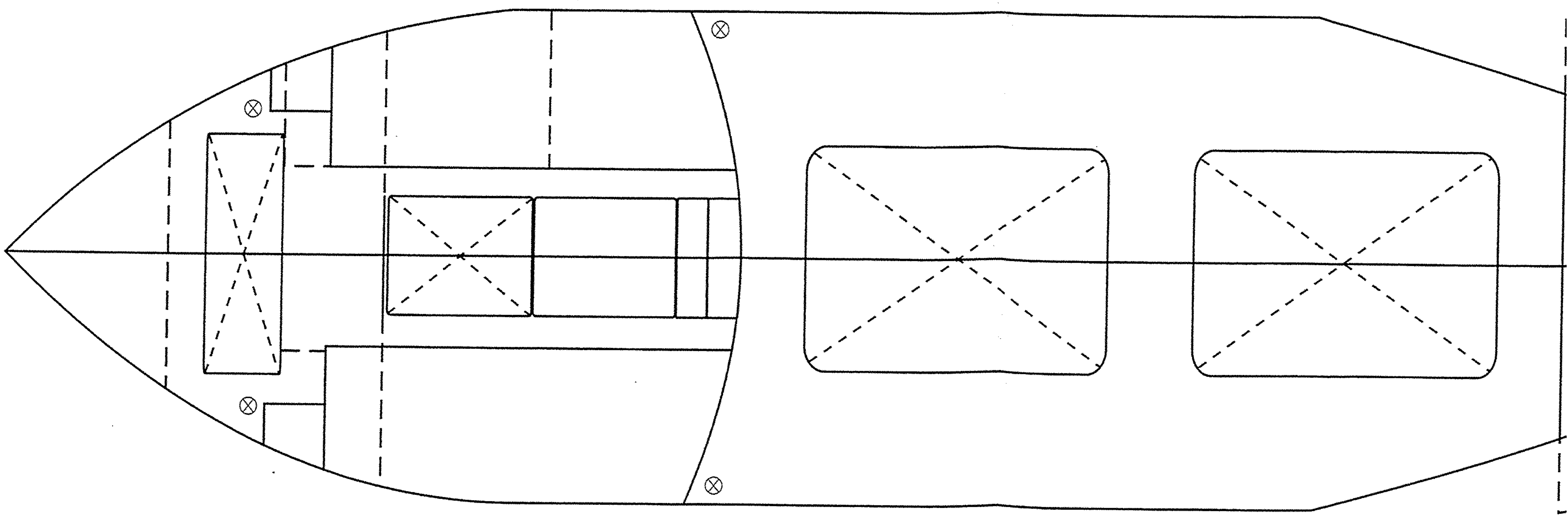


Figure Q-1. Plan and Profile. (sheet 1 of 4).

NOTE:
Drawings not to scale.
Derived from poor quality original. DC plates provided by Honduran government.



NOTE:
Drawings not to scale.
Derived from poor quality
original. DC plates provided
by Honduran government.

Main Deck

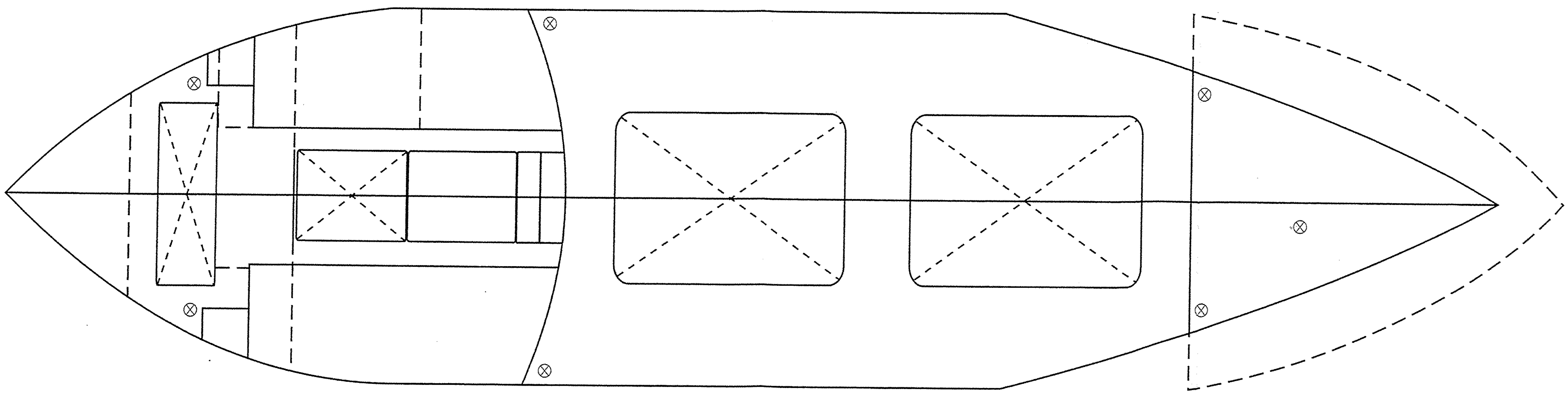


Figure Q-1. Main Deck. (sheet 2 of 4).

NOTE:
Drawings not to scale.
Derived from poor quality original. DC plates provided by Honduran government.

Second Deck

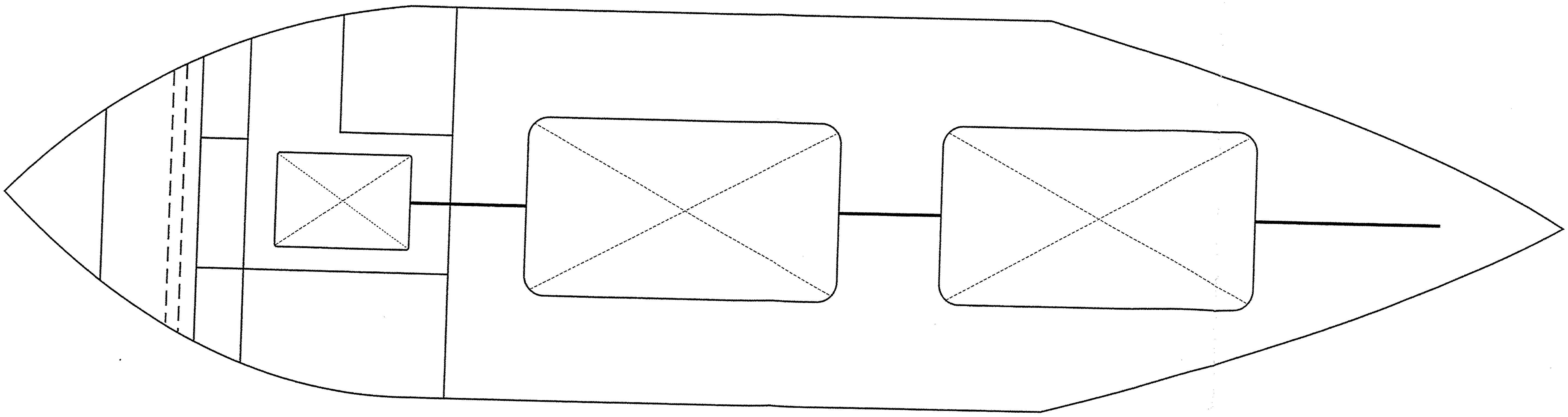


Figure Q-1. Second Deck. (sheet 3 of 4).

NOTE:
Drawings not to scale.
Derived from poor quality original. DC plates provided by Honduran government.

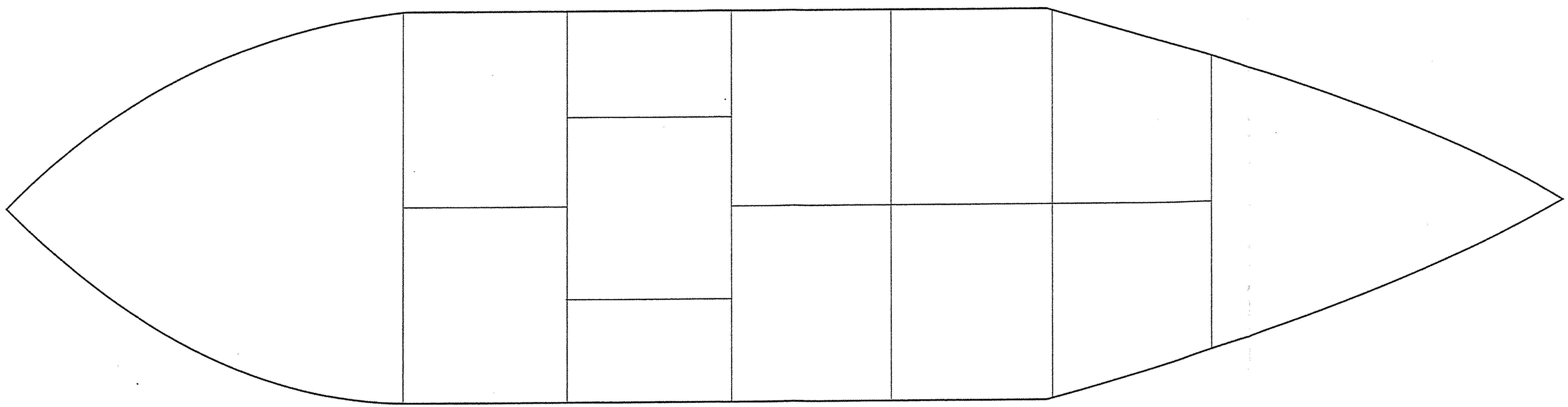


Figure Q-1. Double Bottoms. (sheet 4 of 4).

APPENDIX R

YC CHARACTERISTICS

The enclosed figures present the general data for the YC barge used during the salvage operations.

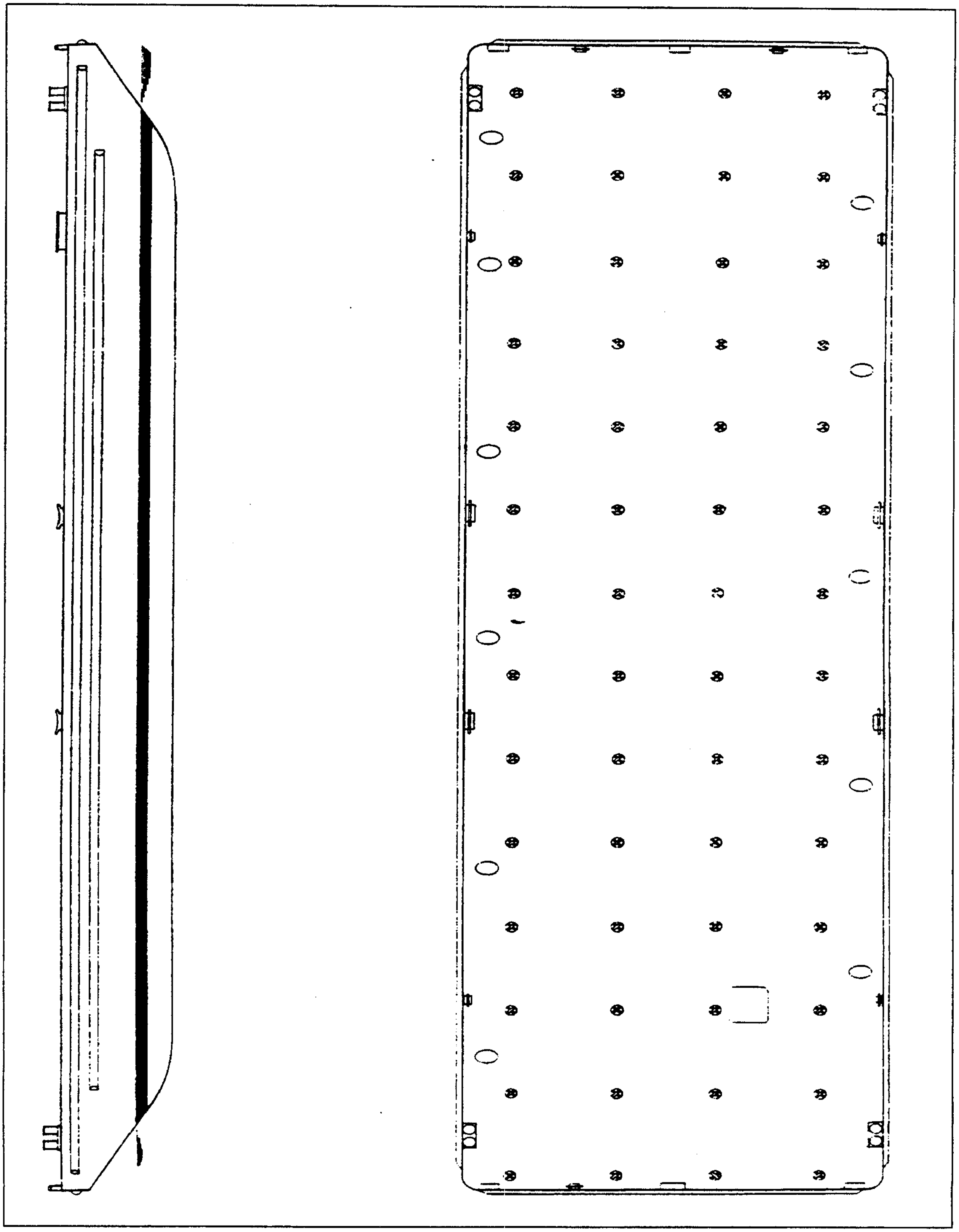


Figure R-1. Profile and Arrangement YC

APPENDIX S

SIGNIFICANT MESSAGES

EXHIBITS **PAGE**

R 272302Z AUG 92
FM AMEMBASSY TEGUCIGALPA
TO SECSTATE WASHDC 1319
USCINCSO QUARRY HEIGHTS PM//SCCC/SCDC/SCJ3/SCJ3-EX/SCJ5//
CINCLANTFLT DET SO FT AMADOR PM
CINCLANTFLT NORFOLK VA
DSAA WASHDC
AMEMBASSY MEXICO 0114
AMEMBASSY GUATEMALA 0210
AMEMBASSY SAN SALVADOR 0139
AMEMBASSY MANAGUA 0139
AMEMBASSY SAN JOSE 0166
CNO WASHDC//OP-06//
COMNAVSEASYSCOM WASHDC//OOC//
COMJTF-B SOTO CANO AB HO//COM/J3-EX//
NAVSPECWARUNIT EIGHT
COMSUPPRON EIGHT
UNCLAS TEGUCIGALPA 11850
SUBJ: OIL SPILL AVERTED IN THE BAY ISLANDS...AND PHASE TWO?

1. SUMMARY: PHASE ONE OF THE BAY ISLANDS SHIPWRECKS PROJECT IS OVER -- THOUSANDS OF GALLONS OF SLUDGE OIL HAVE BEEN REMOVED FROM THE MOST DILAPIDATED WRECK, THE PUMPS AND BOOMS HAVE BEEN STORED AWAY, THE USN PERSONNEL HAVE PACKED UP AND GONE HOME. WITH THE OPERATION, THE US GAINED CONSIDERABLE PUBLIC RELATIONS BENEFITS, AND HELPED TO AVERT AN ECOLOGICAL CRISIS AT THE PERSONAL REQUEST OF HONDURAN PRESIDENT RAFAEL LEONARDO CALLEJAS. THE PROJECT ALSO BROUGHT TOGETHER SOME STRANGE BED-FELLOWS (ISLANDERS AND MAINLANDERS RARELY COORDINATE THEIR EFFORTS TOWARDS THE SAME END). THE QUESTION REMAINS: CAN THE US/GOH/ISLANDER COMBINATION THAT WORKED SO WELL THE LAST TIME BRING ABOUT PHASE TWO -- THE ACTUAL SALVAGE OF THE THREE WRECKS REMAIN? ACTION REQUESTS FOR MIL-ITARY ADDRESSEES FOLLOW IN PARS 12-19. END SUMMARY.

2. A MINIATURE DESERT STORM -- THE OIL REMOVAL PROJECT INVOLVED CONTRIBUTIONS, LARGE AND SMALL, FROM SO MANY DIFFERENT SOURCES THAT IT SOMETIMES SEEMED A MINIATURE DESERT STORM. THE GOH PAID FOR THE OPERATION OUT OF A $2 MILLION LEMPIRA (ABOUT $355,000 USD) FUND APPRO-PRIATED FOR THE BAY ISLAND SHIPWRECKS. THE HONDURAN AIR FORCE LOANED THE USE OF ONE OF THEIR C-130S, A BARGE TO TAKE THE OIL FROM ONE ISLANDER, A BARGE TO TAKE THE SOLID WASTE FROM SOMEONE ELSE, A WAREHOUSE TO STORE THE EQUIPMENT CAME FROM A THIRD AND A FOURTH PROVIDED ON-SITE HONDURAN SUPERVISION, ETC. ACCOMMODATIONS AND FOOD WERE PAID FOR BY A GROUP OF THE FIVE LARGEST RESORT OWNERS.

THIS JOINT EFFORT APPROACH SHRUNK COSTS, BUT MORE IMPORTANTLY MAY HAVE HELPED GIVE THE ISLANDERS MORE OF A VESTED INTEREST IN ONE OF THEIR FIRST COMMUNAL ENVIRONMENTAL VENTURES. WE BELIEVE RECENT DEVELOPMENTS REPORTED TO CONGEN ARE NOT COINCIDENTAL - COMMUNITY LEADERS MET AND DECIDED TO CEASE RAISING CATTLE, WHOSE GRAZING NEEDS AND OTHER BODILY FUNCTIONS HAD CAUSED SEVERE DEFORESTATION ON THE SCENIC ISLAND OF ROATAN.

- WHAT WE GOT OUT OF IT -

4. THE U.S. ALSO REAPED SOME PUBLIC RELATIONS REWARDS FOR THE OIL

REMOVAL. HERMAN ALAN PADGET, A COMMENTATOR FOR THE NATIONAL RADIO NETWORK HRN KNOWN FOR HIS ACERBIC, ANTI-U.S. EDITORIALS, WAS HEARD PRAISING THE U.S. FOR OUR CONSERVATION EFFORTS IN THE PROJECT. THE OPERATION RECEIVED COVERAGE IN BOTH LOCAL CONSERVATIVE NEWSPAPERS LA PRENSA AND EL HERALDO. THE LATER PROCLAIMED THE CORAL REEFS OF ROATAN VIRTUALLY SAVED BY THE OPERATION TO REMOVE THE OIL FROM THE TULUM, WHICH PRESENTED THE GREATEST DANGER TO THE ENVIRONMENT AND THE ISLAND POPULATION.

5. GOODWILL ON THE ISLAND TOWARDS THE U.S. -- ALREADY WIDESPREAD -- HAS ALSO BEEN FOSTERED BY U.S. EFFORTS THERE. ALTHOUGH SIGNIFICANTLY LESS OIL ON THE WRECK WAS FOUND THAN HAD BEEN PREDICTED BY PREVIOUS.U.S. SITE SURVEYS, THE CONCLUSIONS OF A UNDP ENVIRONMENTAL STUDY CONFIRM THAT THIS SMALLER AMOUNT WOULD HAVE DECIMATED THE SURROUNDING REEF TOO.

-- STRANGE BEDFELLOWS --

6. ONE OF THE BIGGEST SURPRISES BROUGHT ABOUT BY THE OIL OPERATION WAS THAT THE ENTIRE UNDERTAKING, WHILE LED AND COORDINATED BY POST AND THE USN, WAS FUNDED BY THE GOH IN CASH UPFRONT AND BY THE IN-KIND CONTRIBUTIONS OF THE ISLANDERS. IN ADDITION, THE COOPERATIVE NATURE OF THE OPERATION IS NOTEWORTHY PRIMARILY BECAUSE IT INVOLVED BOTH THE ISLANDERS AND THE MAINLAND GOVERNMENT, BRIDGING THE GAPS OF AN UNEASY RELATIONSHIP, ONE IN WHICH THE WORDS PIRATE AND SPANISH STILL RANKLE.

-- LOOKING TO THE FUTURE...PHASE TWO? --

7. WHILE THE COMPLETION OF PHASE ONE WAS CRITICAL, THE SECOND PART OF THE PROJECT -- THE DISPOSAL OF THE THREE WRECKS THEMSELVES -- IS ALSO IMPORTANT. ONE OF THESE WRECKS, THE WENDY, IS LODGED IN THE CHANNEL AT COXEN'S HOLE. MOST OF THE LEADERS OF THE ROATAN COMMUNITY HAVE EXPRESSED AN INTEREST IN HAVING THE WENDY REMOVED. THOSE WHO MAKE THEIR LIVING FROM TOURISM SAY THE WRECK BLOCKS CRUISE SHIPS FROM ENTERING THE HARBOR. ISLANDERS ENGAGED IN THE FISHING INDUSTRY WANT TO CLEAR UP THE CHANNEL FOR THEIR OWN USE. THE OTHER TWO WRECKS POSE ENVIRONMENTAL THREATS DUE TO THE FUEL RESIDUE AND OXIDATION OF THEIR HULLS, BUT THEIR REMOVAL IS LESS PRESSING AT THIS STAGE. POST PLANS A FINAL BRIEFING FOR THE ISLANDERS TO REVIEW THEIR ACCOMPLISHMENTS OF PHASE ONE AND TALK ABOUT PHASE TWO.

- MONEY MATTERS -

8. TO THE MIND OF MOST HONDURAN POLITICOS, THE TWO MILLION LEMPIRAS ALREADY APPROPRIATED FOR THE PROJECT IS INTENDED TO TAKE CARE OF THE WRECKS. IT IS QUESTIONABLE THAT THE GOH WILL PROVIDE ADDITIONAL FUNDING, AS INDICATED BY COGENS PRIVATE CONVERSATIONS WITH THE HONDURAN CONGRESS' PRESIDENT FITO IRIAS NAVAS, AND WITH VICE PRESIDENT CARLOS KATTAN. THE WORDS OF THESE MEN HAVE ADDED WEIGHT IN THIS MATTER BECAUSE THEY ORCHESTRATED THE INITIAL GRANT TO THE PROJECT.

9. IN ADDITION, THE MAINLAND-BASED PRIVATE SECTOR HAS YET TO COME FORWARD WITH FINANCIAL SUPPORT FOR THE PROJECT, DESPITE A SERIES OF BRIEFINGS GIVEN BY EMBOFFS AND ORGANIZED IN PART BY ADOLFO FITO FACUSSE, HEAD OF A NATIONAL INDUSTRIALISTS GROUP (ANDI).

- WHAT WE HAVE TO WORK WITH -

10. TWO MILLION LEMPIRAS EQUALS ABOUT $355,000 USD, OF WHICH APPROXIMATELY $145,000 USD REMAINS IN AN EMBASSY TRUST FUND. ABOUT $210,000 USD HAS ALREADY BEEN PAID TO THE USN. POST HAS NOT YET RECEIVED THE ACCOUNT-

ING FROM PHASE ONE OF THE PROJECT FROM THE USN CONTRACTORS NOR THE HONDURAN AIR FORCE.

11. COMMENT: THE US REAPED SUBSTANTIAL BENEFIT FROM THE FIRST PHASE OF THE BAY ISLANDS PROJECT, NOT LEAST THE AVOIDANCE OF AN OIL SPILL ON THE BREATHTAKING ROATAN COASTLINE. POSITIVE PUBLICITY AND ENHANCED CREDIBILITY ON THE ISLAND WERE ALSO REWARDS, AS WAS THE TRADITIONAL FOCUS ON ENVIRONMENTAL PROBLEMS IN THE ISLANDS. WHETHER PHASE TWO HAPPENS DEPENDS IN LARGE PART ON HOW THE U.S. MILITARY CLASSIFIES THE MISSION.

END COMMENT.

-- FOR MILITARY ADDRESSEES --

12. EVEN THOUGH NAVSEA SALVAGE EXPERTS ELIMINATED THE MOST IMMEDIATE THREAT TO ROATAN'S MARITIME ENVIRONMENT BY REMOVING THE SLUDGE OIL FROM THE TULUM, THE THREE SHIPWRECKS STILL LITTER ROATAN'S PRISTINE SHORES AND CONTINUE TO POSE A LONG TERM THREAT TO THE BARRIER REEF. REMOVAL OF THESE VESSELS IS PROGRAMMED FOR PHASE II OF THE ROATAN SALVAGE PROJECT. GOH PRIORITIES FOR PHASE TWO ARE 10 SALVAGE WENDY FROM THE COXEN'S HOLE NAVIGATION CHANNEL, 2) SALVAGE TULUM FROM ATOP THE BARRIER REEF, AND 3) REMOVE ALEXANDER FROM THE BEACH.

13. AS ORIGINALLY DISCUSSED DURING SITE VISITS OF JUNE AND JULY, SALVAGE OF THESE THREE VESSELS CONTINUES TO OFFER A CHALLENGING AND UNIQUE TRAINING EXPERIENCE FOR BOTH USN SALVAGE DIVERS BASED IN CONUS AND SEAL COMBAT DIVERS FROM NAVSPECWARUNIT EIGHT IN PANAMA (FOR SEALS ONLY ABOARD ALEXANDER USING CUTTING TORCHES AND C4 DET CORD).

14. REQUEST SOUTHCOM AND CINCLANTFLT (WITH CNO'S CONCURRENCE) SERIOUSLY CONSIDER SALVAGING ONE OR MORE OF THE THREE VESSELS AS A DFT DURING FIRST OR SECOND QUARTER FY-93. FUNDING RESTRAINTS AND NORMAL 12-18 MONTH PLANNING/EXECUTION CYCLES FOR DFTS ARE FULLY APPRECIATED, BUT THE CALIBER OF FORWARD DEPLOYED UNIT TRAINING OFFERED BY SALVAGING THESE VESSELS IN A REMOTE FOREIGN LOCATION WITH SOME OF THE WORLDS BEST DIVING CONDITIONS CAN'T BE DUPLICATED IN THE MURKY WATERS OF THE CHESAPEAKE BAY OR ELSEWHERE IN CONUS.

15. ASIDE FROM PROVIDING EXCEPTIONAL REAL WORLD SALVAGE TRAINING TO A NAVY SALVAGE DIVING UNIT OR ATF SALVAGE VESSEL'S CREW, DEVELOPING PHASE TWO AS A DFT WOULD FURTHER ENHANCE THE USG'S POSTURE WITHIN HONDURAS.

16. IN ADDITION, STARTUP AND EXECUTION FOR A DFT AT ROATAN DURING THE NEXT SIX MONTHS WILL BE AVAILABLE TO THE USN AT BARGAIN BASEMENT PRICES. APPROXIMATELY 70 PERCENT OF THE SALVAGE MATERIALS REQUIRED FOR PHASE TWO WERE PREVIOUSLY AIRLIFTED TO ROATAN DURING PHASE ONE, AND NAVSEA HAS A GREED TO STORE THESE MATERIALS IN A WAREHOUSE ON ROATAN FOR UP TO SIX MONTHS. PHASE TWO AIR LIFT REQUIREMENTS WOULD ONLY INVOLVE 1-2 MORE C-130 SHUTTLES FROM NORFOLK TO ROATAN, AND A K-LOADER UPON INITIATION AND COMPLETION. THUS 1) MOST OF THE SALVAGE EQUIPMENT IS ALREADY ON SITE AND WILL BE STORED THROUGH THE END OF SECOND QUARTER FY93, 2) THE HONDURAN AIR FORCE COULD FLY THE REMAINING SHUTTLE MISSIONS TO NORFOLK AND THUS DRASTICALLY REDUCE DFT AIRFLOW COSTS, AND 3) LOCAL RESIDENTS WILL CONTINUE TO PROVIDE MANY BIG CASH FLOW ITEMS LIKE BARGE AND CRANE RENTAL AT NO COST AS PART OF AN ASSISTANCE-IN-KIND PROGRAM BY CONCERNED CITIZENS.

17. THE MILGRP NAVY CHIEF ESTIMATES THAT ALL THREE VESSELS COULD PROBABLY BE SALVAGED FOR UNDER 150,000 USD AS A DFT WHEN ASSISTANCE-IN-KIND AND REDUCED AIR FLOW EXPENDITURES ARE FACTORED INTO THE EQUATION. THE EMBASSY STILL HAS APPROXIMATELY 150,000 USD LEFT OVER FROM PHASE ONE THAT COULD BE USED TO OFFSET THOSE COSTS NOT COVERED UNDER THE AUSPICES OF A DFT.

18. IN SUMMARY, CONTINUED SOUTHCOM, CNO, CINCLANTFLT AND NAVSEA ASSISTANCE IS NEEDED TO RAPIDLY ACTIVATE PHASE TWO OF THE ROATAN SALVAGE PROJECT AS ONE OR MORE DFTS DURING FY-93. WITH THE BEST INTERESTS OF THE USN AND USG IN MIND, REQUEST SOUTHCOM AND CINCLANTFLT REVIEW THEIR FY-93 EXERCISE/DFT SCHEDULES AND ATTEMPT TO PROGRAM A SALVAGE DFT TO ROATAN INTO THE FIRST OR SECOND QUARTER. REQUEST SOUTHCOM RESEARCH FOLLOWING ACTION ITEMS AND PROVIDE INPUT TO COUNTRY TEAM (ATTN:APUGH), JTF-BRAVO AND MILGRP:

A) DETERMINE IF AN ACTIVE DUTY/RESERVE USN SALVAGE UNIT OR AN ATF/OTHER SALVAGE VESSEL IS AVAILABLE TO DEPLOY TO ROATAN FOR A 6-8 WEEK DFT DURING FY-93.

B) PROVIDE ESTIMATED DEPLOYMENT DATES OF DFT PERSONNEL TO ROATAN.

C) PROVIDE A FINE-TUNED ESTIMATE OF WHAT ACTUAL COSTS ARE COVERED WITHIN A DFT'S CHARTER WILL BE, I.E., MORE OR LESS THAN CURRENT $150,000 USD
ESTIMATE.

D) DETERMINE K-LOADER AVAILABILITY FOR A DFT STARTING IN FIRST OR SECOND QUARTER.

E) DETERMINE HOW MANY ADDITIONAL SHUTTLE MISSIONS FROM NORFOLK WOULD BE REQUIRED.

F) DETERMINE IF NAVSPECWARUNIT 8 IS INTERESTED IN ASSISTING IN THE SALVAGE OF THE ALEXANDER.

19. THE PROFESSIONAL SUPPORT FROM DOD DURING PHASE ONE WAS GREATLY APPRECIATED. I'M SURE WE CAN ACCOMPLISH THE PHASE TWO DFT WITH THE SAME SPIRIT OF MUTUAL COOPERATION.

ARCOS.

191542Z JAN 93
FM   CINCLANTFLT NORFOLK VA//N332/N3/N33//
TO   CNO WASHINGTON DC//N3/N5//
      CDR FORSCOM FT MCPHERSON GA//J3//
INFO COMNAVSURFLANT NORFOLK VA//32/N3/33//
      COMNAVSEASYSCOM WASHINGTON DC//OOC//
      CINCLANTFLT DET SO FT AMADOR PM//00/N3//
      AMEMBASSY TEGUCIGALPA
      NAVY IPO WASHINGTON DC//02//
      COMLOGGRU TWO
      COMSUPPRON EIGHT
UNCLAS //N03120//
MSGID/GENADMIN//CINCLANTFLT N332E/007/JAN//
SUBJ/HONDURAN SHIPWRECK SALVAGE//
A. GENADMIN/AMEMBASSY TEGUCIGALPA/272302ZAUG92/-/NOTAL//
B. CON/CINCLANTFLT/20DEC92//
C. TEL/COMSUPPRON EIGHT/12JAN93//
REF A IS ORIGINAL REQ FOR USN SALVAGE ASSISTANCE. REF B WAS CONFERENCE BTWN CLF N3/RADM HAYDEN AND CLF DET SO/CAPT STANBRIDGE. REF C IS PHONCON BTWN LT HILL (SUPPRON EIGHT)/MAJOR RODRIGUEZ (FORSCOM).//
1. RECENT CHANGES IN 3RD QTR COMMITMENTS SUPPORT AN FMS FUNDED DFT SALVAGE OPERATION DURING APR-MAY '93 AS REQ REF A. AS DISCUSSED REF B, THE SALVAGE OF THESE VESSELS REMAINS A HIGH PRIORITY WITH THE GOH.
2. BASED UPON AVAILABLE TIME/ASSETS, ORIG CAN SUPPORT SALVAGE AND REMOVAL OF ONE SHIP ONLY. SUBJECT TO OPNAV CONCURRENCE AND CONFIRMATION OF FUNDING, ORIG WILL SKED SALVAGE OF THE SUNKEN VESSEL WENDY.
3. FOR FORSCOM: IRT REF C, REQ USE OF ARMY BD FM PERIOD FEB 93-MAY 93 TO ASSIST IN JOINT SALVAGE OF WENDY. REQ DIRLAUTH.

211604Z JAN 93
FM   COMUSMILGP TEGUCIGALPA HO//SCHO-CO//
TO   NAVYIPO WASHDC//
INFO SECDEF WASHDC/DSAA-OPS-MAR//
SECSTATE WASHDC//PM-SAS//
JOINT STAFF WASHDC//J4/J5//
USCINCSO QUARRY HEIGHTS PM//SCJ5-PM/SA/SCCC/SCDC/SCJ3//
CINCLANTFLT DET SO FT AMADOR PM
COMNAVSEASYSCOM WASHINGTON DC//PMS 3802/000//
CINCLANTFLT NORFOLK VA//N332/N31A/NS/N43/N02P/N53//
COMNAVSURFLANT NORFOLK VA//37/N3/32/73/N6/31//
AMERICAN EMBASSY TEGUCIGALPA//JJJ//
COMLOGGRU TWO
COMSUPPRON EIGHT
COMNAVSPECWARGRU TWO//00/N3//
NAVSPECWARUNIT EIGHT//N3//
MOBDIVSALV TWO
UNCLAS TEGUCIGALPA HO 00550
SUBJECT: AMENDMENT TO HO-P-GAU (BAY ISLAND, ROATAN SHIPWRECK OPERATIONS)
A. LOA, HO-P-GAU SALVAGE OPERATIONS FOR SHIPWRECK TULUM
B. NAVY IPO 292143X SEP 92, FMS CASE HO-B-GAU
1. THE LOA HAS OPENED IN JULY 1992 TO FUND THE US NAVY SALVAGE OPERATIONS FOR SHIPWRECK TULUM. THE HONDURAN GOVERNMENT IS INTERESTED IN CONDUCTING A SECOND PHASE OF THE SHIPWRECK OPERATION DURING THE MAR-APR 93 TIMEFRAME. PER REF B THE CASE CURRENTLY HAS $85,598.78. IN JULY 92, THE HONDURAN GOVERNMENT DEPOSITED FUNDS IN THE U.S. AMERICAN EMBASSY TO SUPPORT FOLLOW-ON OPERATIONS. THE BUDGET AND FINANCE SECTION WILL TRANSFER USD 90,000 TO DEFENSE FINANCE AND ACCOUNTING SERVICE (DFAS), ATTN: DE/SAAC/F DENVER CO 80279-5000 TO SUPPORT THE PHASE II OF THE OPERATION.
2. THE NAVSPECWARUNIT 8 PANAMA, COMSUPPRON 8 NORFOLK, VA, AND THE U.S. MILITARY GROUP WILL CONDUCT A SITE SURVEY IN ROATAN DURING 23-25 JAN 93. THESE UNITS WILL OFFER THE HONDURAN GOVERNMENT OPTIONS FOR CONDUCTING THE SALVAGE OPERATION. THE FIRST PRIORITY FOR THE SECOND PHASE IS TO SALVAGE THE WENDY. IF TIME AND FUNDS PERMIT, THE HONDURAN GOVERNMENT WOULD ALSO WANT TO SALVAGE THE ALEXANDER.
3. REQUEST THAT YOU COORDINATE WITH NAVSEASYSCOM AFTER THE PRE-SITE SURVEY TO OBTAIN COST DATA.
4. POC IS MAJ PINA/MR CASTILLO: DSN (CONUS) 449-5219; DSN (PM) 280-5219; COMM (504) 33-6242.

092025Z FEB 93
FM COMSUPPRON EIGHT
TO USS GRAPPLE
USS GRASP
MOBDIVSALU TWO
USNS MOHAWK
INFO CNO WASHINGTON DC
CINCLANTFLT NORFOLK VA
COMNAVSURFLANT NORFOLK VA
COMSECONDFLT
COMNAVSEASYSCOM WASHINGTON DC
CDR FORSCOM FT MCPHERSON GA
CINCLANTFLT DET SO FT AMADOR PM
AMEMBASSY TEGUCIGALPA
SECDEF WASHINGTON DC
CJCS WASHINGTON DC
JOINT STAFF WASHINGTON DC
COMLOGGRU TWO
USCINCSO QUARRY HEIGHTS PM
NAVSPECWARUNIT EIGHT
COMNAVSPECWARGRU TWO
UNCLAS //N04740//
MSGID/GENADMIN/COMSUPPRON EIGHT//
SUBJ/COMSUPPRON EIGHT LOI 93-005, SALVAGE OPERATION BAY ISLAND/ROATAN, HONDURAS OF SHIPWRECK WENDY//
A. RMG/CINCLANTFLT/191542ZJAN93/-/NOTAL//
B. DOC/NSTM/01MAR90//
C. DOC/CINCLANTFLT/06MAY82//
D. RMG/CSR-8/271042ZOCT89/-/NOTAL//
E. DOC/CNO/00NOV87//
F. DOC/NAVSEA/24JUL87//
1. THIS IS COMSUPPRON EIGHT LTR OF INST (LOI) 93-002 FOR THE SALVAGE OF SHIPWRECK WENDY. REF A REFERS.
2. FORCES ASSIGNED:USS GRAPPLE (ARS-53)USS GRASP (ARS-51)MOBDIVSALU TWO USNS MOHAWK (T-ATF-170)
3. TASK ORG:
A. CTU 40.5.8, COMMANDER, COMBAT SUPPORTSQUADRON EIGHT
B. CTE 40.5.8.9, CO, USS GRAPPLE; TE 40.5.8.9, USS GRAPPLE
C. CTE 40.5.8.8, CO, USS GRASP; TE 40.5.8.8, USS GRASP
D. CTE 40.5.8.13, MOBDIVSALU TWO; TE 40.5.8.14, MOBDIVSALU TWO DET A
E. CTE 40.5.8.2, MASTER, USNS MOHAWK; TE 40.5.8.2, USNS MOHAWK
4. COMMAND RELATIONSHIP:
(1) COMMANDER, COMSUPPRON EIGHT IS OPERATIONAL COMMANDER AND ON SCENE COMMANDER FOR CONDUCT OF SALVAGE MISSION.
(2) MOBDIVSALU TWO WILL PROVIDE SERVICE AS SALVAGE MASTER AND DIVING OFFICER.
(3) USS GRASP AND USS GRAPPLE WILL PROVIDE SALVAGE SVCS AS DELINEATED IN SALVAGE PLAN.
5. EXECUTION: THIS LOI IS EFFECTIVE IMMEDIATELY UPON RECEIPT FOR PLANNING PURPOSES AND EXECUTION O/A 22 FEB 1993.

FOR ALL UNITS:
A. ASSIST IN DEVELOPMENT OF SALVAGE PLAN IAW REF B.
B. DEVELOP A HEAVY WEATHER PLAN TO INCLUDE PROVISIONS FOR RECOMMENDATIONS FM NAVEASTOCEANCEN NORFOLK VA.
C. SUBMIT OPAREA CLNCS REQUEST AS REQUIRED.
D. SUBMIT DIPLOMATIC CLNC REQUEST AS REQUIRED.
E. FOR USNS MOHAWK:EMBARK MOBDIVSALU TWO DET A O/A 22 FEB 93 AND PROCEED TO VIC BAY ISLAND, ROATAN, HONDURAS WITH TANDEM TOW OF 3 WORK BARGES. COMMENCE SALVAGE OPERATIONS IAW SALVAGE PLAN.
F. FOR USS GRASPPROCEED TO ROATAN O/A 08 MAR 93. UPON COMPLETION, PROCEED IAW EMPSKED.
G. FOR USS GRAPPLE: PROCEED TO ROATAN O/A 10 APR 93 IAW EMPSKED. UPON COMPLETION OF SALVOP, TOW WORK BARGES TO LITTLE CREEK AS DIRECTED IN EMPSKED.
6. COMMUNICATIONS/REPORTS:
A. DIRLAUTH ALCON
B. ON SCENE COMMANDER KEEP ALCON ADVISED VIA DAILY SITREPS IAW REFS C AND D DURING SALVOPS. OTHER REPORTS AS REQUIRED REF E.
C. CSR-8 WILL PREPARE A CONSOLIDATED SALVAGE RPT IAW REF F WITHIN 30 DAYS OF COMPLETION OF SALVOPS.
7. FUEL CONSERVATION: ALL EFFORTS WILL BE MADE TO TAKE ADVANTAGE OF CURRENTS, WEATHER AND THE ECONOMICAL AND EFFICIENT OPERATIONS OF THE ENGINEERING PLANT TO PERMIT MINIMUM FUEL CONSUMPTION.
8. SAFETY: SAFETY IS PARAMOUNT THROUGHOUT THE CONDUCT OF THE SALVOP. DUE REGARD FOR SAFETY OF PERS AND EQUIP WILL BE STRESSED AT ALL LEVELS. DURING PLANNING STAGES POTENTIALLY HAZARDOUS SITUATIONS WILL BE IDENTIFIED AND PRECAUTIONARY MEASURES DEVELOPED. A DESIGNATED SAFETY OBSERVER, UNENCUMBERED BY OTHER DUTIES, WILL OBSERVE ALL HAZARDOUS EVOLUTIONS. DEVELOPMENT OF ANY UNSAFE CONDITIONS WILL BE CAUSE FOR A STOPPAGE OF ALL WORK UNTIL THE SITUATION IS RECTIFIED AND ALL CONCERNED ARE SATISFIED THAT IT IS SAFE TO CONTINUE. AT NO TIME WILL PERS OR EQUIP BE SUBJ TO UNDUE RISKS. ADDITIONALLY, SALV OPS WILL BE CONDUCTED WITH DUE REGARD TO WEAX RECOMMENDATIONS.
9. ENVIRONMENTAL PROTECTION: DUE REGARD WILL BE HELD FOR ALL PRACTICES POTENTIALLY DAMAGING TO THE ENVIRONMENT OR IN VIOLATION OF LOCAL ENVIRONMENTAL LAW. PARTICULAR CAUTION WILL BE EXERCISED IN REMOVAL OF FUEL, CARGO, AND OTHER HAZARDOUS MATERIAL THAT MAY BE ENCOUNTERED. ENSURE PROPER HANDLING AND DISPOSITION OF HAZMAT.

211830Z APR 93
FM USS GRASP
TO COMSUPPRON EIGHT
COMLOGGRU TWO
INFO CNO WASHINGTON DC
CINCLANTFLT NORFOLK VA
COMNAVSURFLANT NORFOLK VA
COMSECONDFLT
CINCLANTFLT DET SO FT AMADOR PM
AMEMBASSY TEGUCIGALPA
SECDEF WASHINGTON DC
JOINT STAFF WASHINGTON DC
COMNAVSEASYSCOM WASHINGTON DC
USCINCSO QUARRY HEIGHTS PM
UNCLAS
MSGID/GENADMIN/GRASP//
SUBJ/SALVAGE OF THE SHIPWRECK WENDY IN BAY ISLANDS, ROATAN, HONDURAS SPECIAL SITREP//
RMKS/1. WENDY HAS BEEN DISPOSED OF AT LAT16-17.9N4/LONG 086-37.2W6. GOH REPRESENTATIVE CONCURRED WITH AND DIRECTED THE DISPOSAL. WENDY SANK CLEAN OF ALL FUEL AND OIL. NO CARGO OR FLOTSAM WAS NOTED AFTER SINKING.
2. SALVAGE TEAM SUFFERED A CATASTROPHIC FAILURE OF INSTALLED MAIN ENGINEROOM SUBMERSIBLE PUMP. SAILORS MADE A VALIANT AND HEROIC EFFORT TO SAVE THE SHIP AND CONTINUE THE TRANSIT. BUILDING SEAS AND HIGH WINDS ASSOCIATED WITH A FRONTAL SYSTEM PASSAGE MADE THE TASK IMPOSSIBLE. ON-SCENE COMMANDER WITH CONCURRENCE OF GOH REPRESENTATIVE ORDERED DISPOSAL RATHER THAN CONTINUE THE TRANSIT AND POSSIBLY JEOPARDIZE PERSONNEL OR EQUIPMENT SAFETY.
3. USS GRASP IS CURRENTLY ENROUTE COXEN HOLE HARBOR, ROATAN WITH YFN AND YC IN TOW. COMMODORE GIBSON SENDS.