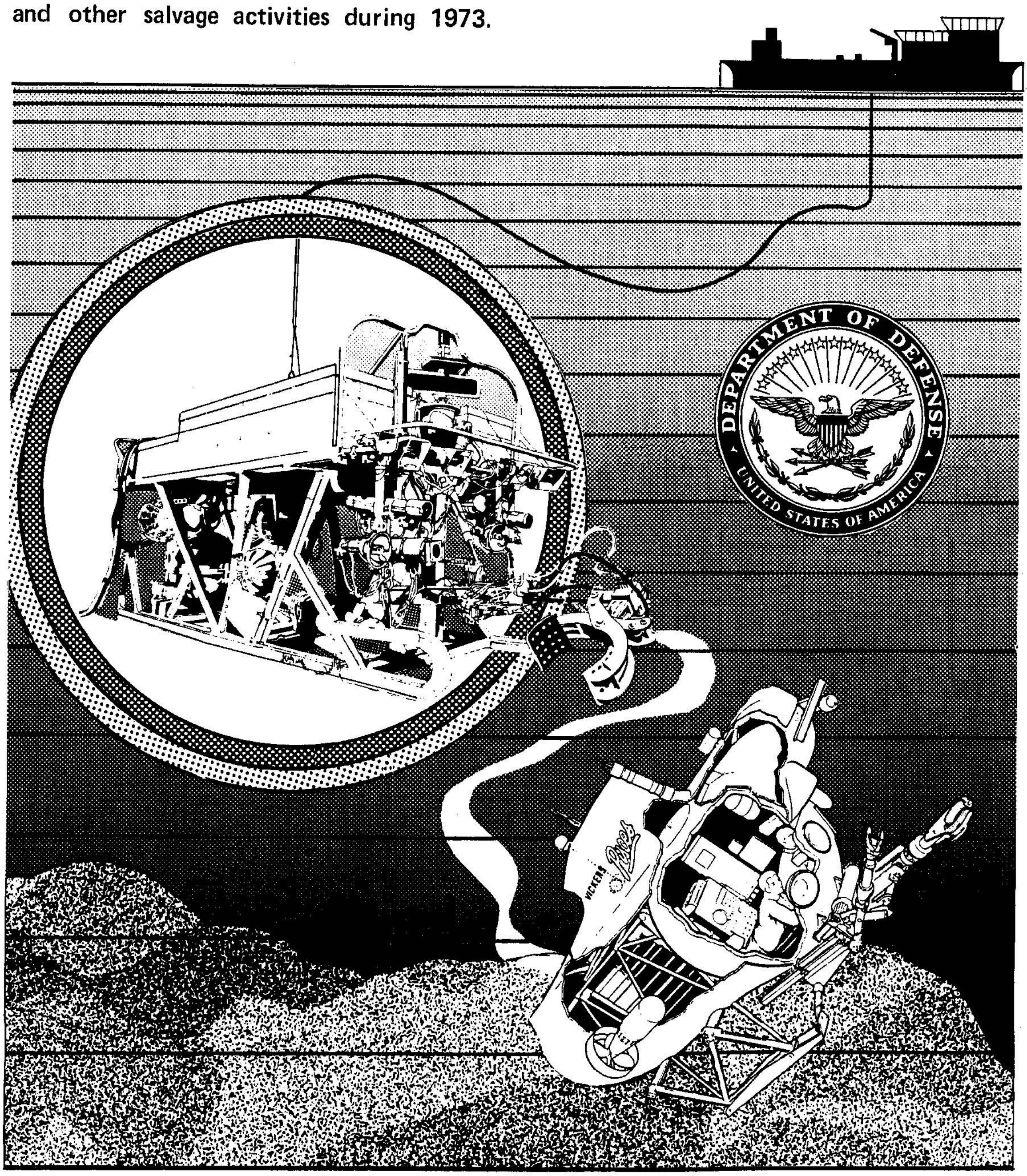
NAVSEA 0994-LP-012-6050

SALVOPS 73

A review of significant salvage operations conducted by U.S. Navy salvage forces and other salvage activities during 1973.



Department of the Navy
Naval Sea Systems Command
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WASHINGTON, D.C. 20362

FOREWORD

The Supervisor of Salvage issues the annual edition of the SALVOPS series to provide the salvage community with an exchange of useful professional information, techniques, and ideas.

As described in this volume, the 1973 salvage operations constitute a representative cross-section of effort, as well as, a useful mix of problems that were resolved by skillful techniques and imaginative approaches.

Although no two salvage incidents are alike, each of their components - depth, pressure, weather, materials, and equipment - usually has been dealt with before. It is the particular combination of these factors that, inevitably, is different and challenging.

For these reasons, the chronical of operational techniques and motivation set forth in SALVOPS 73 should be of value to salvors planning future operations. A further value will accrue as reflection on these problems stimulates the development of new techniques and improved equipment.

ROBERT B. MOSS
CAPTAIN, USNR
Supervisor of Salvage

1 August 1977

ABSTRACT

SALVOPS is a review of significant salvage operations conducted by the Supervisor of Salvage (SUPSALV), U.S. Navy, during 1973. This includes operations of U.S. Navy salvage forces and those of contractor salvors working under the auspices of SUPSALV. The operations reported in this review are intended for general reading by those interested in the current state of the salvage art. It relates three operations involving deep ocean technology: the dramatic recovery of the British crewmen of PISCES III from 1,600 feet, the support effort required by the Azores Fixed Acoustical Range (AFAR), and the recovery of the wreckage of a P-3B antisubmarine aircraft from the Gulf of Maine. New and time saving capabilities are reported in the accounts of the foam sink-proofing of an LST, and the underwater repairs of USS F.D. ROOSEVELT. Details are reported of the typhoon-defeated attempts to retract the USNS JACK J. PENDLETON, stranded in the South China Sea. Useful clearance work is described in the removal of the tug wreck from Coney Island Channel, and the removal of fouled ground tackle from Estero Bay (the latter effort requiring installation of antipollution measures). The usual summary of downed aircraft recovery operations also is provided, in addition to a report of special recovery operations conducted to identify personnel lost in Southeast Asian waters.

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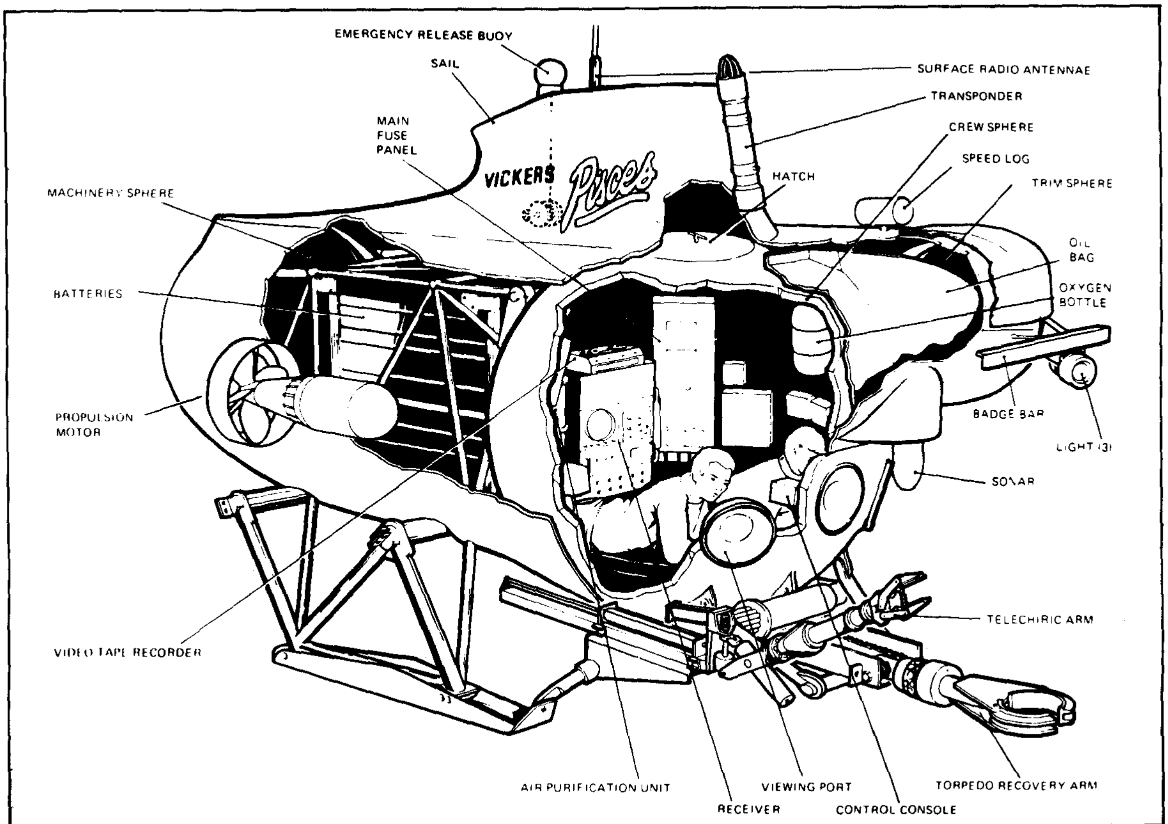
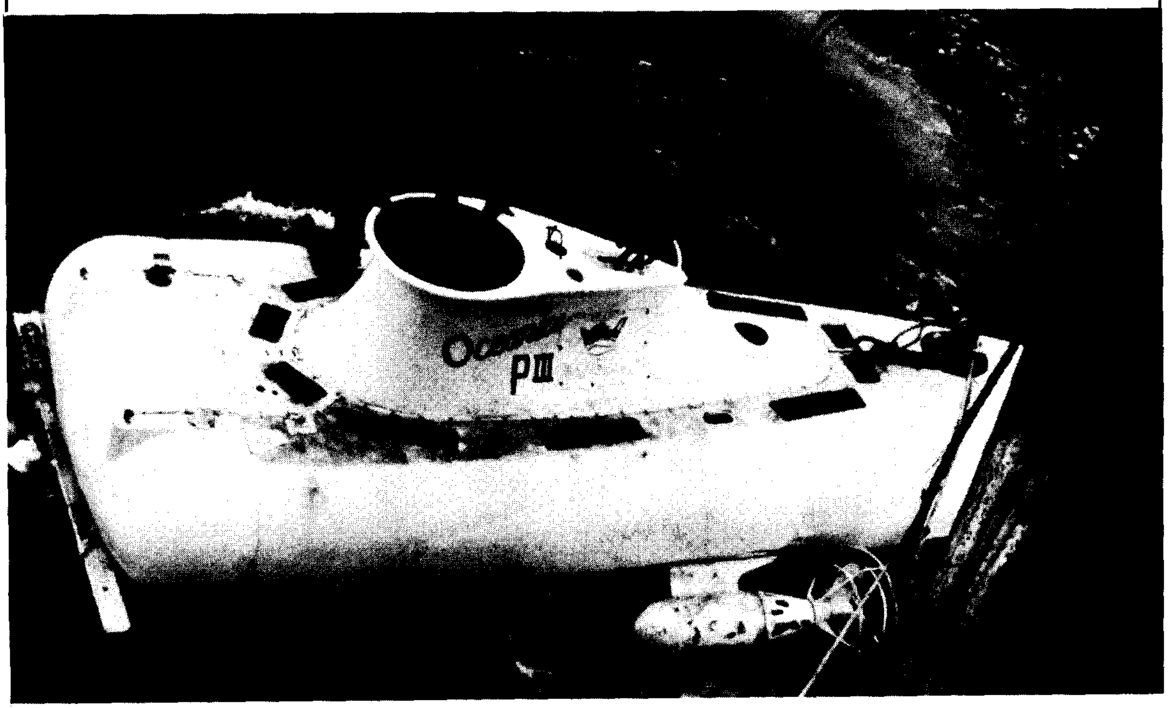
RESCUE OF THE

DEEP SUBMERSIBLE PISCES III

FROM 1,600 FEET





PISCES was trapped with two crewmen, at 1,600 feet, when a hatch was ripped open, flooding its engineering space.

PISCES III, A TYPE OF COMMERCIAL DEEP SUBMERSIBLE

RESCUE OF THE DEEP SUBMERSIBLE PISCES III FROM 1,600 FEET

INTRODUCTION

The Canadian commercial submersible, PISCES III, was lost during recovery from normal operations in August 1973, southwest of Cork, Ireland. The 12-ton, 19-1/2 foot, two-man craft, sank in 1,575 feet of water when its tow-line fouled and pulled open the hatch to its after compartment, which completely flooded. PISCES lost positive buoyancy instantly and ended up on the bottom with two trapped crewmen and only 72 hours of life support.

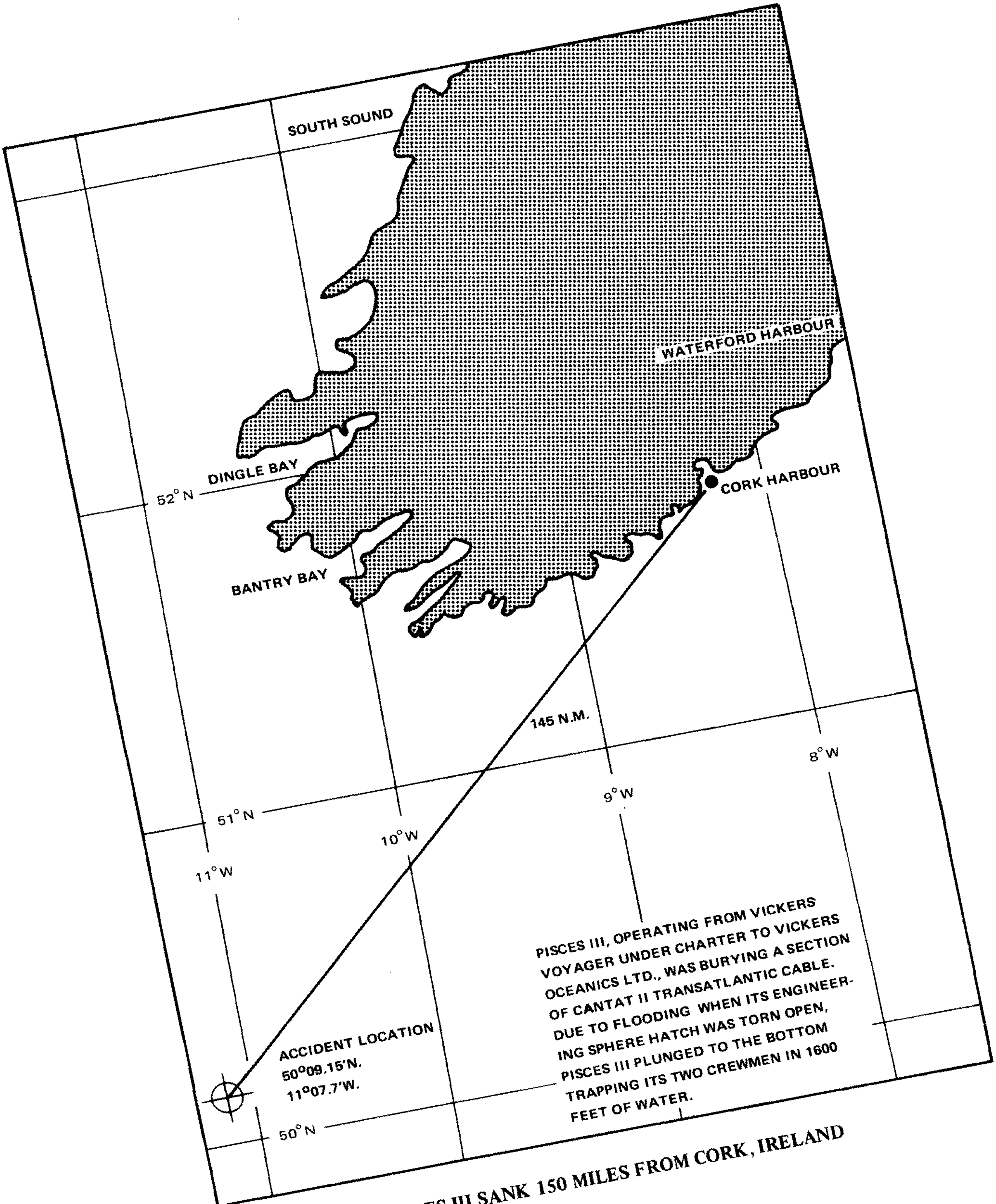
Designed primarily for commercial work, PISCES III was the third in line of submersibles designed by International Hydrodynamics (HYCO) of Vancouver, B.C., for a variety of deep ocean operations to depths of 3,500 feet. At the time of the accident, PISCES III had been on the sea bottom working on a transatlantic cable.

At the request of British authorities, CURV III (Cable-Controlled Underwater Recovery Vehicle) was flown from San Diego to Ireland where it was operated from the Canadian Coast Guard Ship JOHN CABOT. In coordination with PISCES II and V, CURV was successful in inserting a togglebar in the open hatch of PISCES III, with which the trapped submersible and crew were safely hauled to the surface 76 hours after the initial mishap.

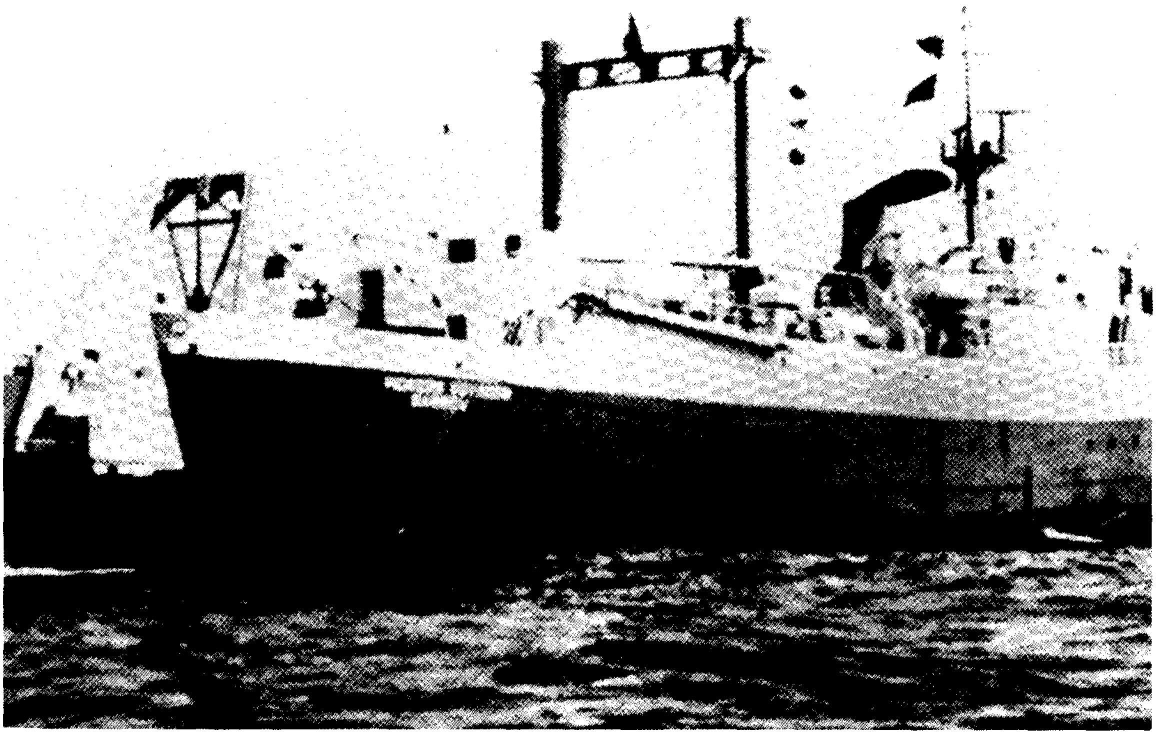
LOSS OF PISCES III

The Accident

On 29 August 1973, PISCES III, a two-compartment, 12-ton submersible, was working on a submarine cable at 1,600 feet, off the coast of Ireland. Under charter to Vickers Oceanics Ltd., she was burying a 12-mile section, from 1,200 feet down to 3,000. This work on CANTAT II, a new 1,840-channel cable being installed by the Canadian Overseas Telecommunications Corporation, was needed to protect the cable from damage from fishing trawls. Surfacing after a 5-hour dive, PISCES was taken under tow preparatory to



PISCES III SANK 150 MILES FROM CORK, IRELAND



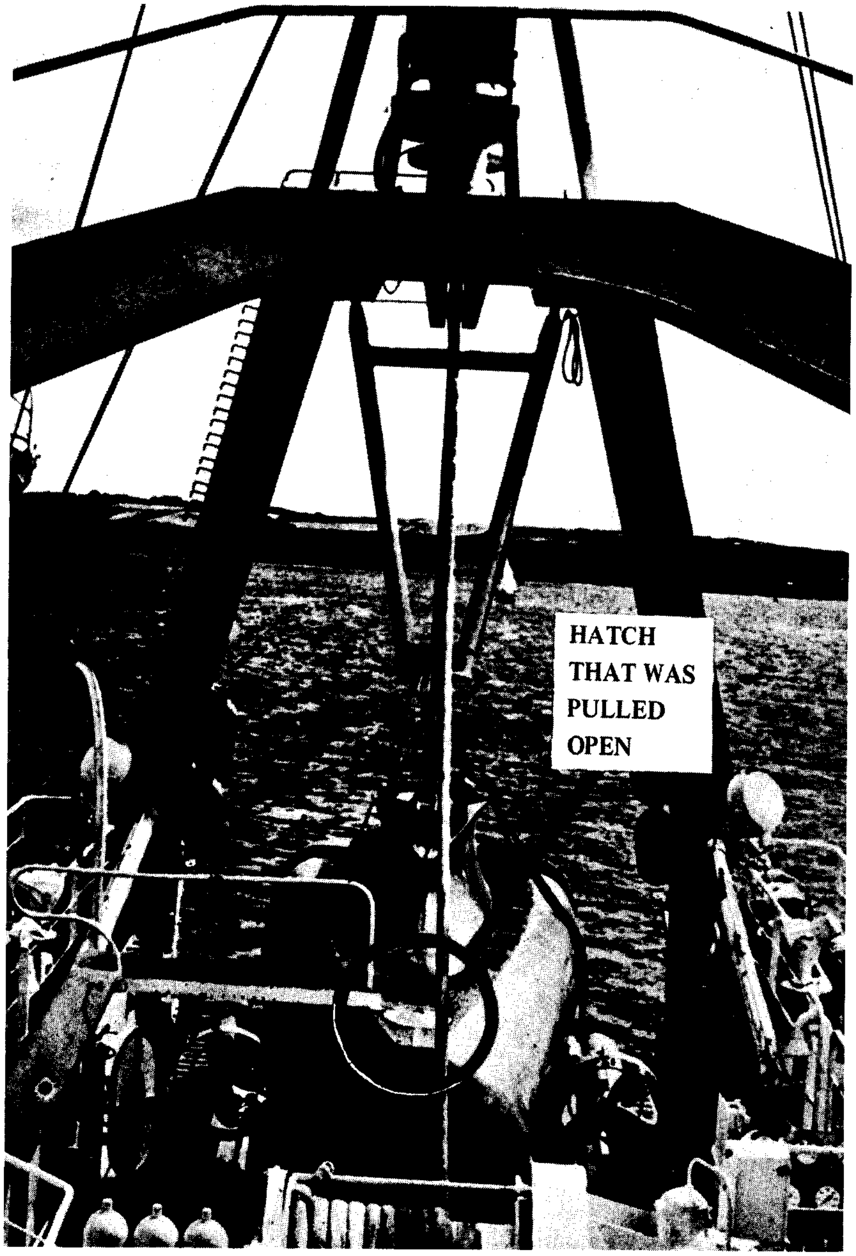
PISCES III was being hauled in, stern first, to VOYAGER's after-mounted A-frame recovery-lift, when its engineering sphere hatch was torn open.

VICKERS VOYAGER, MOTHER SHIP FOR PISCES III

recovery, and was brought, stern first, to within 100 yards of its mother ship, VICKERS VOYAGER, preparatory to being hoisted aboard with VOYAGER's special A-frame lift. At this point, a bight in the recovery painter tangled the after hatch cover of the minisub and yanked it open, spilling two tons of sea water into the after engineering sphere. PISCES III sank instantly to the length of the light painter, which parted in about 12 minutes. PISCES III then plummeted the remainder of the 1575 feet to the bottom.

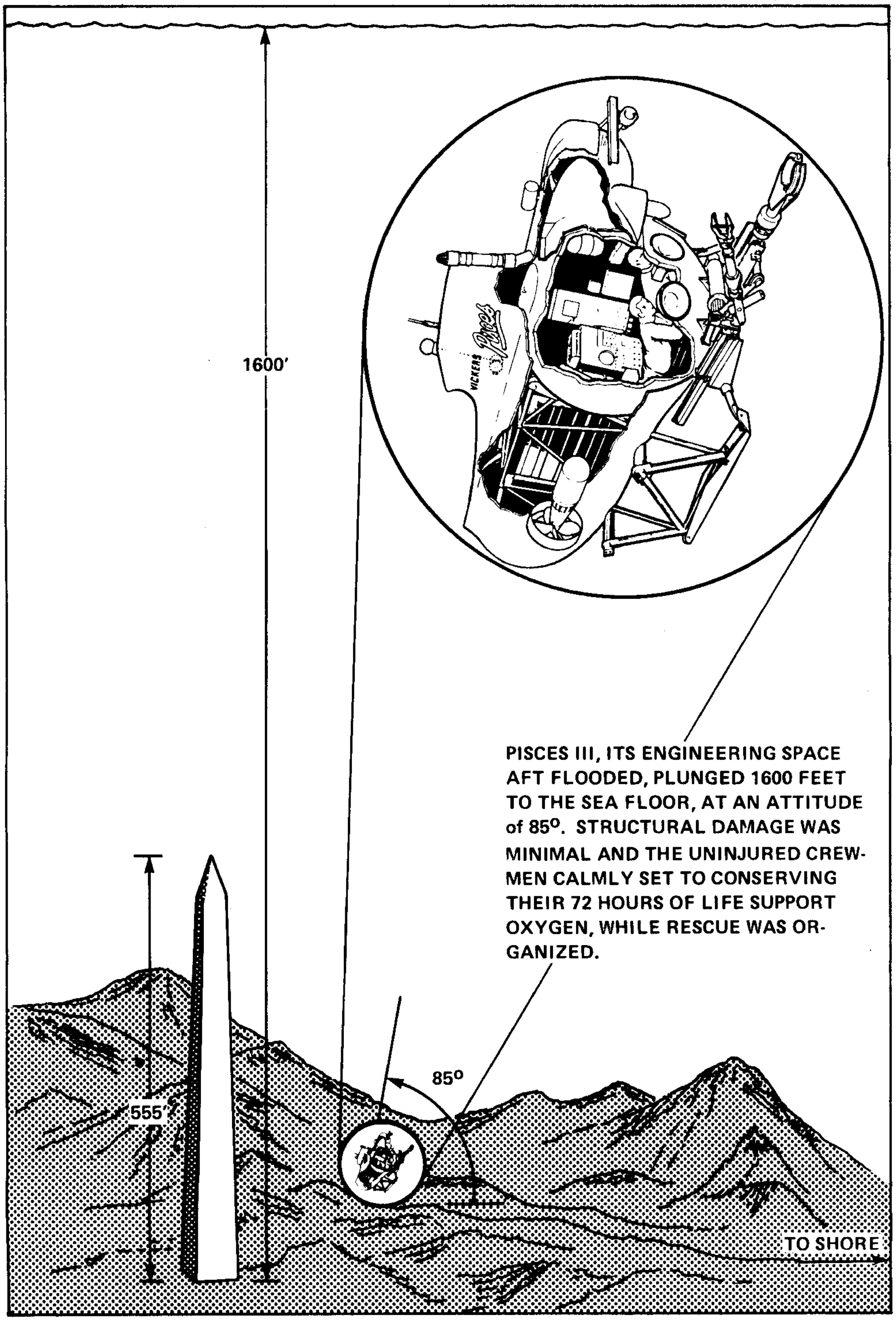
Situation on Bottom

Although the craft struck stern first in hard sand at about 17 knots, the impact caused little damage to the 20-foot craft's batteries, life support, or structure. The two-man crew



PISCES III was still some distance from the recovery position, as shown above, when a surge in the sea painter caused a bight to foul the handle of the after hatch and pull it open, causing flooding of the after sphere.

RECOVERY POSITION FOR PISCES III

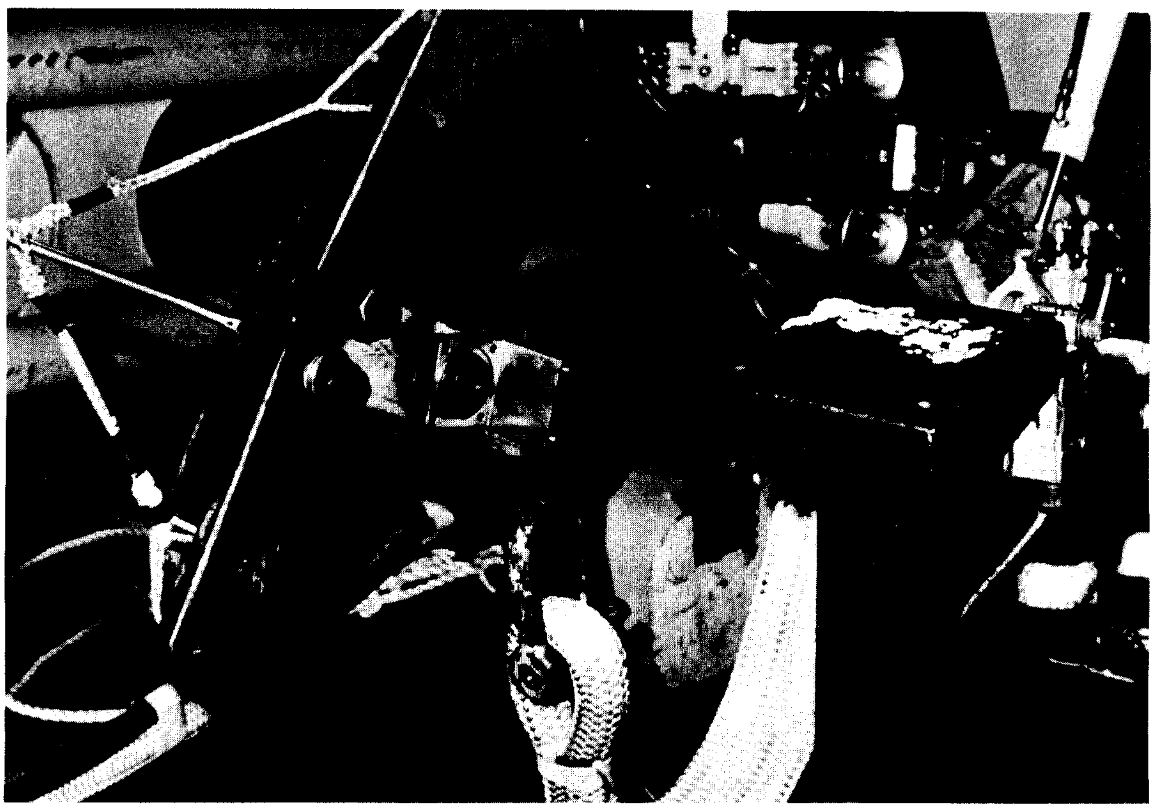


BOTTOMED SITUATION OF PISCES III

reported themselves in good physical condition, with adequate water and a little food, but with only 72 hours of life support. Vickers, Barrow, was notified and went into action to conduct rescue. PISCES III was stuck in an 85°, bow-up position, some 150 miles southwest of Cork. VICKERS VOYAGER remained in voice and sonar contact with PISCES III, and two marker buoys were put out. The accident occurred about 1000 Wednesday morning, 29 August. Life support was computed to last until late Saturday morning or early afternoon. PISCES III crew were ordered to remain as inactive as possible to conserve life support.

Background Situation

Upon being advised of PISCES III emergency, Vickers Oceanics Ltd. at Barrow-in-Furnace, England, on the Irish Sea, assumed control of the rescue operation. They



This bungee-loaded toggle was rapidly designed and fabricated by Vickers Oceanics to satisfy rescue requirements. A backup unit was also built. The prudent judgment involved is underlined by the subsequent need for both toggles in the successful rescue effort.

LIFTING TOGGLE FABRICATED TO RESCUE PISCES III

reviewed the status of the situation and the rescue assets, and set in motion necessary planning and operations. It was quickly decided that rescue could only be achieved by attaching a line to PISCES III and lifting it to the surface.

The careful attention to detail and backup redundancy (in British parlance: "belt and braces planning") exhibited by Vickers must be appreciated. The impressive logistical and operational participation of a U.S. salvage team, which was in fact ultimately responsible for saving PISCES III and its crew, should not obscure the importance of Vickers' willingness to request U.S. Navy backup, long before attrition of their own original and backup rescue units could have been anticipated. As a consequence, CURV was available, on-site, as a *third* alternative that could and did contribute the necessary additional operations to save two lives with only hours to spare.

SITUATION ANALYSIS

Constraints

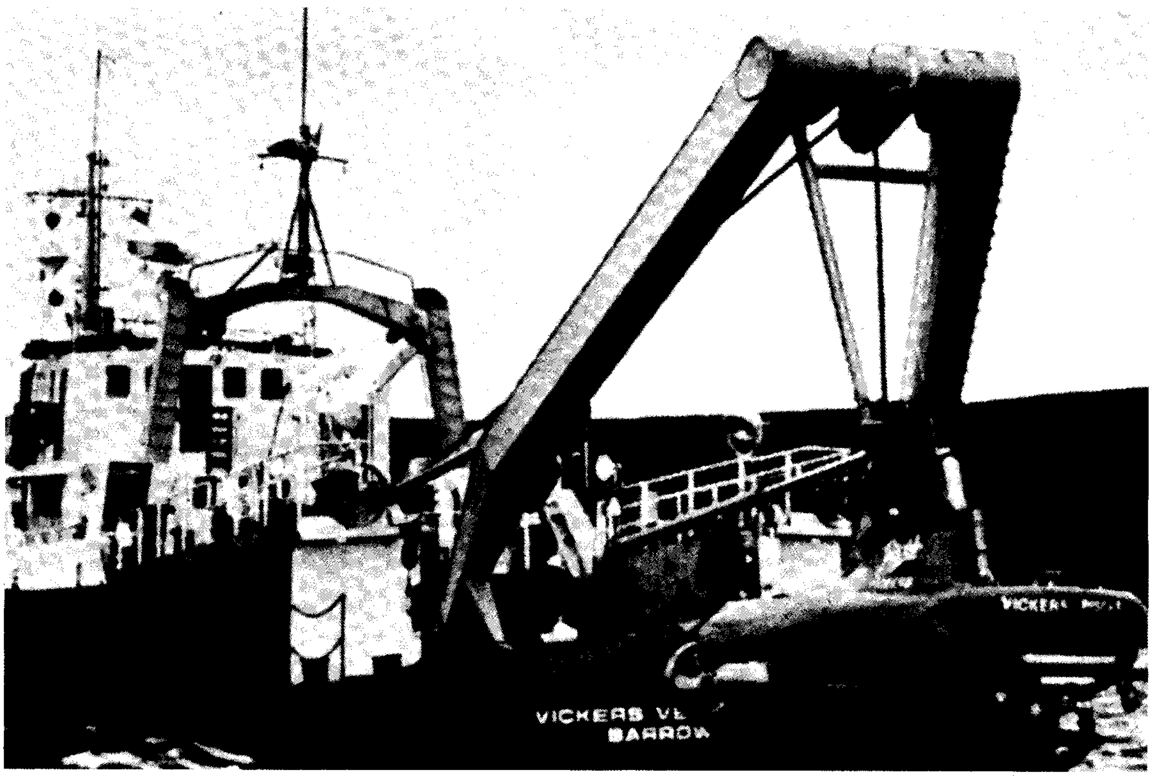
Since PISCES III is a commercial submersible, the rescue presented several logistical problems. First, commercial submersibles are generally designed to perform specific ocean engineering tasks, so their size, hull form, and equipment arrangements are quite different from fleet submarines. Second, life support capacity for commercial submersibles is generally limited. Fortunately, in the case of PISCES III, life support capacity was 72 hours. Third, the hatches on commercial submersibles are not compatible with the McCann chamber or other more sophisticated devices used for the deep ocean rescue of trapped crewmen on fleet submarines. Finally, commercial submersibles are not usually designed for escape by buoyant ascent, eliminating that rescue alternative also.

Rescue Concept

Since it had been quickly decided by Vickers, Barrow, on being informed of the emergency, that rescue could be achieved only by attaching a line to PISCES III, and lifting it to the surface, two specially designed toggles were rapidly fabricated by Vickers for rescue use. The toggles were bungee-loaded to permit tripping into an open position after placement inside the PISCES' 14-inch after hatch. This posed requirements for both a submersible and a ship from which operations could be conducted. Since the VICKERS VOYAGER itself was the only unit close at hand, measures had to be taken to provide replacement for its role as on-site voice and sonar monitor. VOYAGER could then proceed to Cork to pick up additional resources needed for rescue.

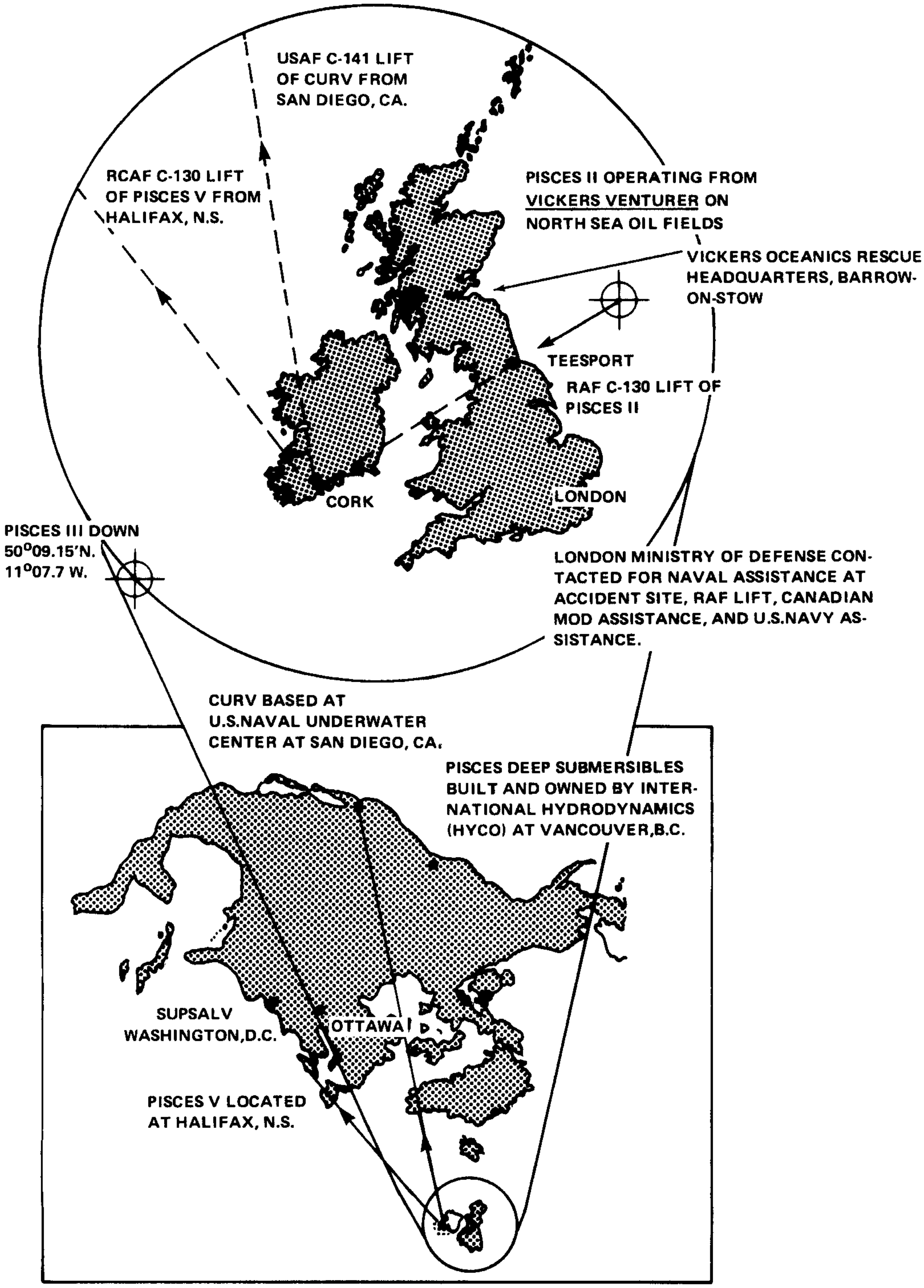
Local Response

The first vessel to arrive on station in response to MAYDAY, was a British Army LST, the Royal Fleet Auxiliary (RFA) SIR TRISTRAM. The Vickers' Controller and Assistant, with portable underwater telephone (AN/UQC), were transferred, freeing VICKERS VOYAGER to proceed to Cork to embark rescue units.



PISCES II, engaged in oil field work in the North Sea, was recovered by its mother ship VICKERS VENTURER, which proceeded to Teesport, England. From there, PISCES II was trucked to the nearest airport for RAF airlift to Ireland.

SISTER SUBMERSIBLE PISCES II WAS RECALLED FROM THE NORTH SEA TO ASSIST IN RESCUE



COORDINATION POINTS AND LOCATION OF RESCUE RESOURCES

Vickers Response

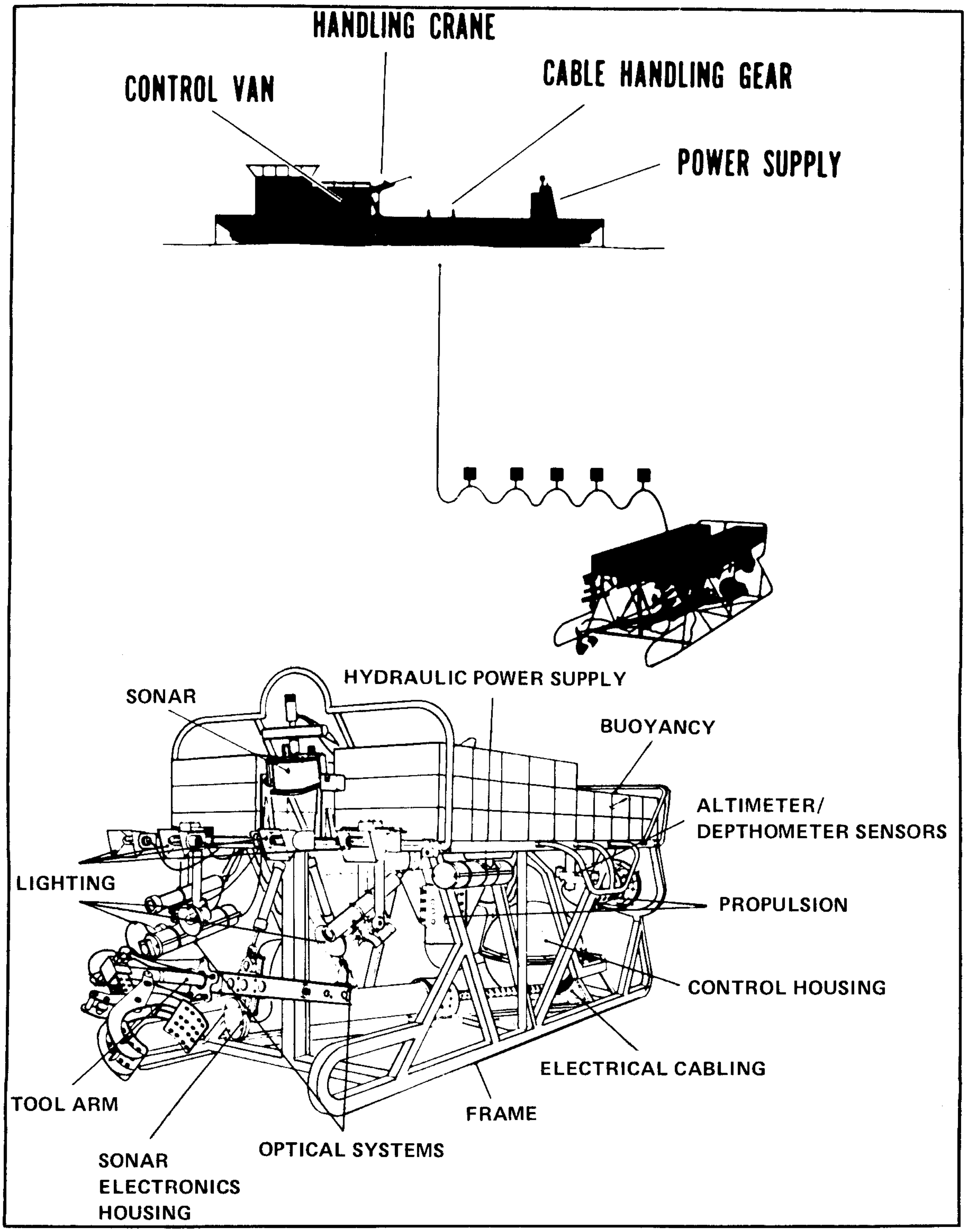
Meanwhile, arrangements were made to obtain and use the other PISCES boats. PISCES II, on oil field support operations in the North Sea with the VICKERS VENTURER, was ordered into the nearest port, Teesport, England. The RAF was requested to provide Hercules (C-130) airlift and backup. A Vickers representative was dispatched as Officer-in-Charge, Teesport, to arrange for berth, crane service, and road-transport to the local airport for Hercules airlift. PISCES V, available at Halifax, Nova Scotia, was requested from HYCO, the builder-owner, in Vancouver, B.C., and RCAF Hercules lift was arranged.

The USAF supplied prompt logistic support by providing two C-141 aircraft to fly the CURV system from San Diego, California to Cork, Ireland.

USAF C-141 AIRCRAFT LIFTED CURV TO IRELAND

U.S. Navy Response

CINCUSNAVEUR in London was notified, who offered all assistance. Vickers then contacted U.S. Navy Supervisor of Salvage (SUPSALV) and made arrangements for the backup services of CURV III. The USS AEOLUS (ARC-3) was also deployed to the scene for general support. Navy's Deputy Supervisor of Salvage immediately alerted the Naval Underwater Center, San Diego, California, and requested that CURV III, support-vans, and operating personnel be made ready for immediate departure for Cork. Two USAF C-141 aircraft were requested to provide logistics lift to Cork. Deputy SUPSALV and SUPSALV's Senior Salvage Master left for Cork on the evening flight. Arrangements had been made for use of the Canadian Coast Guard Ship (CCGS) JOHN CABOT on which to mount and operate CURV.



CURV IIIC VEHICLE SUBSYSTEMS

FUNCTIONING OF CURV SYSTEM

General

The Cable-Controlled Underwater Recovery Vehicle (CURV) was originally designed to locate and recover ordnance and other small objects from water depths to 7,000 feet. CURV III, the latest vehicle of this design, is an unmanned cable-controlled vehicle carrying propulsion motors, lights, underwater television, sonar, and a manipulator arm to which many different tools can be attached. CURV weighs approximately 4,000 pounds, has a descent and ascent speed of 30 feet/minute, and a transit speed of 3 knots when not in the search mode.

CURV System Components

The basic system consists of an open aluminum rectangular frame to which support systems can be readily added to modify the vehicle for a particular task. The other components of the basic system include the control cable, control console in a portable van, power supply and conversion equipment, and surface handling equipment. Syntactic foam blocks attached at the top of the frame produce a slight positive buoyancy. Propulsion and control are provided by three 10-horsepower propulsion motors and an electro-hydraulic command system. Support systems are mounted on the frame. They include active and passive sonar, two closed-circuit television cameras, a 35-mm camera, underwater lights, altimeter, depthometer, and compass.

CURV can do useful underwater work using a tool assembly that projects forward from the bow. A manipulator claw, mounted on the assembly, or other types of tools and lifting devices can be fitted for a particular task.

Controlling CURV

The control systems for CURV are all contained in a portable 10x10x20-foot closed van, installed aboard ship, where the operator receives information which determines the CURV's underwater location and its relative attitude, position, etc. The operator can then maneuver the CURV into position to perform the desired task.

Control personnel in the topside van manipulate three 10-horsepower propulsion systems aboard the vehicle to maneuver it under water. One of them, mounted in the center, is used exclusively for vertical control. The vehicle itself floats with about 10-25 pounds of positive buoyancy, provided by blocks of solid syntactic foam arrayed along the top of the frame. When operating on the bottom, the vertical thruster is used to drive the vehicle down, counteracting the positive buoyancy. The wash is therefore up and away from the vehicle, thus giving the cameras an unobstructed view.

On-Site Operations

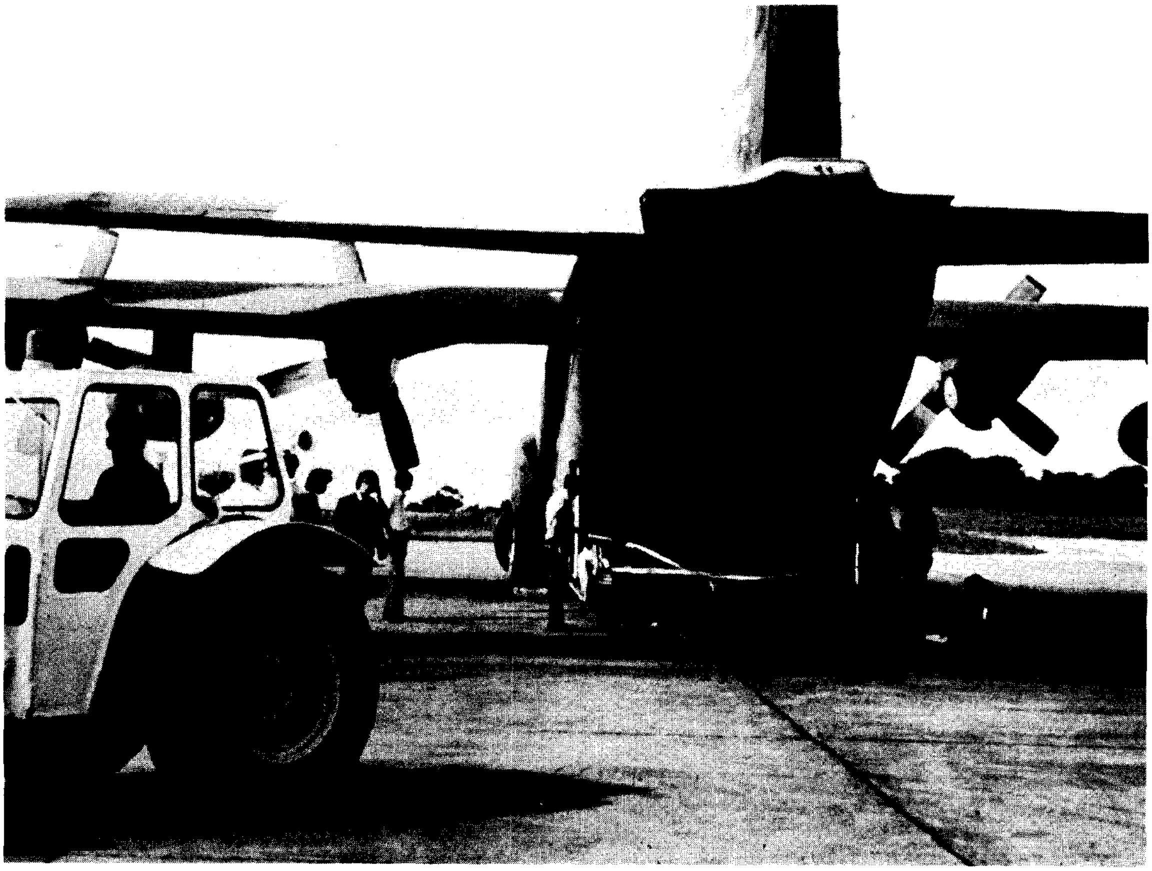
The general location of the salvage object is initially established by surface navigation systems such as Raydist, radar, or LORAC. While the surface support ship keeps station at the worksite, CURV is launched and driven to the bottom. Handling equipment includes a 19-foot articulating crane capable of 5,000-pound lifts for deploying and retrieving the vehicle, a hydraulic traction winch, and a davit and block for handling the nylon line and main cable. Once CURV is on the ocean bottom, a sonar search for the worksite is begun. A SLAD-603 instrumentation system is then used to locate the exact position of the worksite or target.

LOCAL DEPLOYMENTS

The British Ministry of Defence (NAVY), Plymouth, directed the HMS HECATE to proceed to the area with extra lifting line. In response to the urgent need to relieve the VICKERS VOYAGER on station so it could proceed to Cork to pick up the rescue sister-submersibles, an attempt – perhaps ill-considered – was made to have an RAF Maritime Command aircraft take over on-site coverage. An RAF Maritime Command NIMROD patrol aircraft reported on-station in less than 2 hours and dropped a sonar buoy, but understandably and wisely refused responsibility for maintaining contact with PISCES III in the absence of the VICKERS VOYAGER. Less than two hours later, however, the RFA SIR TRISTRAM arrived on-scene and VOYAGER was able to depart. Next morning at 0545, the HMS HECATE arrived on-scene, in turn took the Vickers communication team aboard, and continued communication with the bottomed minisub until the VICKERS VOYAGER returned.

Arrival of PISCES Sistercraft

Early on the 30th, PISCES II and V arrived at Cork Airfield by RAF and RCAF C-130 aircraft, respectively, where necessary arrangements were all set. The submersibles, with



RCAF C-130 aircraft used to fly PISCES V from Canada, arriving at Cork Airfield for PISCES III rescue operations.

PISCES V ARRIVING FROM CANADA

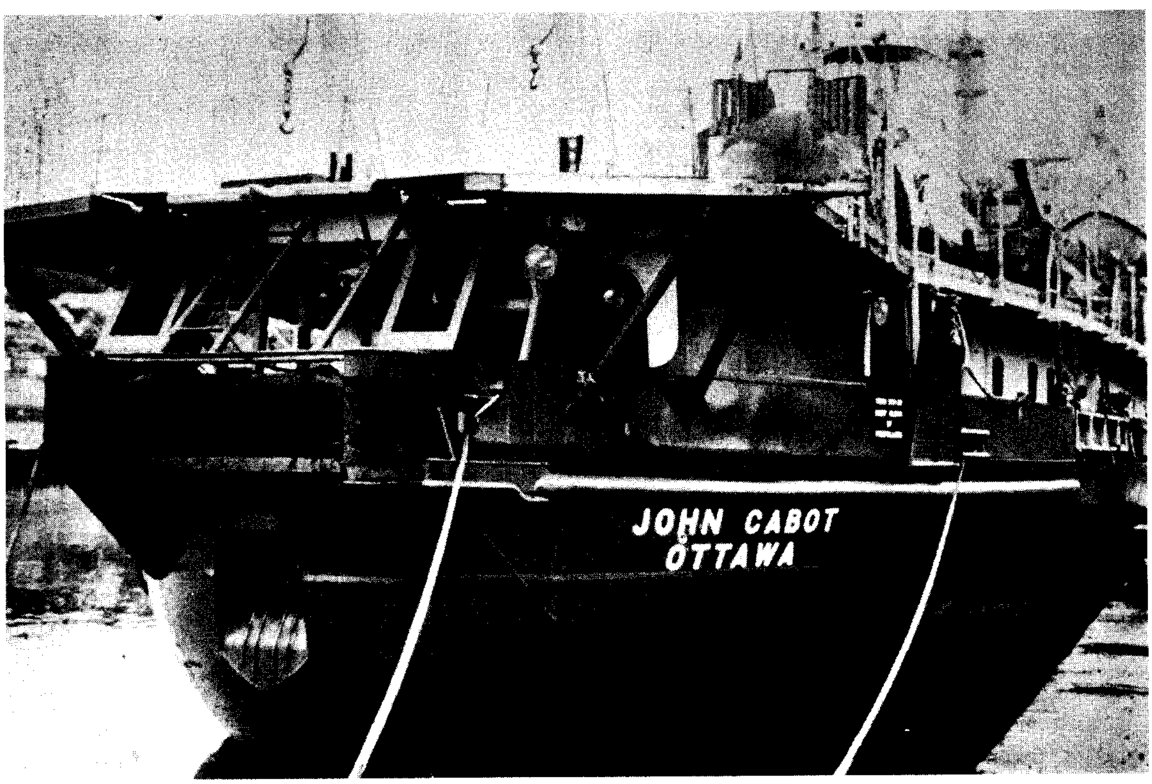
support equipment, were transferred by heavy trailer with police escort, to dockside by 0730. At 0815 VOYAGER was alongside and by 1035, the VICKERS rescue force was under way again to the accident site. About this time, USS AEOLUS arrived on-scene to assist as necessary.

Arrival of CURV

That evening the two C-141 aircraft arrived at Cork Airfield with the CURV III system and team, which were then delivered to Cork where the CCGS JOHN CABOT was now

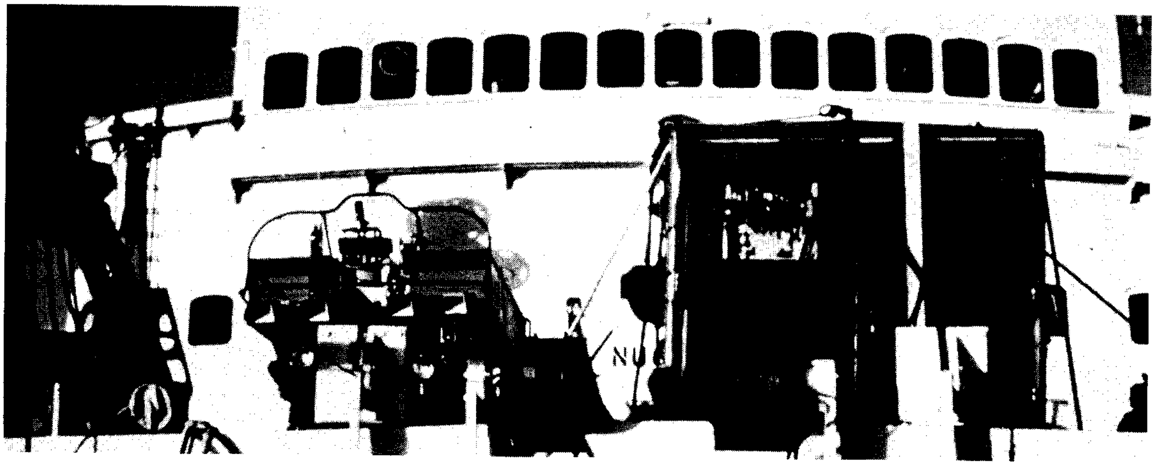
CURV being unloaded from C-141 at Cork Airfield for transfer to Canadian Coast Guard Ship JOHN CABOT, at Cork Harbor.

UNLOADING OF CURV AT CORK AIRFIELD



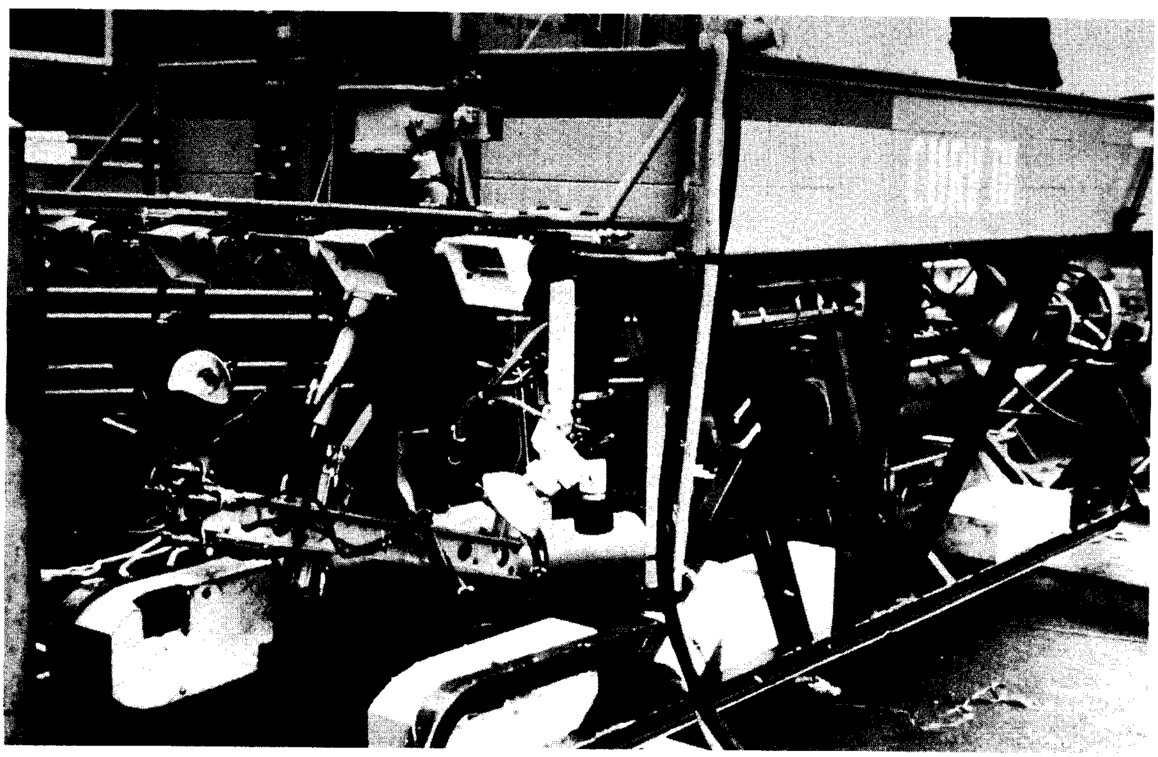
Canadian Coast Guard Ship JOHN CABOT in which CURV system was installed for PISCES III rescue.

CCGS JOHN CABOT



The loading of CURV equipment aboard CABOT was somewhat impeded by the tidal range, which necessitated lightering to mid-stream.

CURV INSTALLATION ABOARD CCGS JOHN CABOT



The underwater element of CURV is inspected after loading on CABOT.

CURV UNDERWATER VEHICLE THAT ATTACHED RESCUE LINE

waiting with the SUPSALV representatives. Loading was complicated by the tidal range at Cork, which did not permit the CABOT alongside during this critical interval. Instead, equipment had to be lightered out by barge, and the CABOT did not get under way until 0645 next morning, Friday, 31 August.

COMMENCEMENT OF RESCUE OPERATIONS

The VICKERS VOYAGER arrived on-station with PISCES II and V at 0100 Friday, 31 August, and at 0200 PISCES II was launched with an 8-inch polypropylene line attached to one of the specially designed rescue toggles. This attempt ended in failure. The buoyancy of the 8-inch polypropylene caused it to be torn from the submersible's manipulator arm, bending it and requiring replacement of its hydraulic elbow-ram.

PISCES Sistercraft Casualties

PISCES V was launched, equipped with a smaller, 4-inch polypropylene line. It then had to spend six and a half hours searching for PISCES III. Several factors caused the search to take abnormally long: an error in the depth reported from PISCES III's depth gauge, abnormal precession of PISCES V's gyro, and jamming of search sonar by screw noise from trawlers chartered by the press – which insisted in crowding the accident site for their "story." (The need for firm control of such salvage peripheral activity is further underlined by one of these trawlers actually severing the marker buoy line early-on in the operation.) During the search it was necessary to recover PISCES V and tow it back to the initial launch position. Two hours later, PISCES III was finally located by sonar, at a range of 800 feet. By now PISCES III had used up 48 of its 72 hours of life support. PISCES V then, with some difficulty, secured a 10-ton-load snap-hook to PISCES III's starboard propeller guard, after earlier attachment to the lift hook had failed. By now, PISCES V was at low battery and was told to bottom alongside PISCES III to provide pinger and UQC homing.

CABOT, with CURV, On-Site

The CCGS JOHN CABOT, with CURV aboard, now arrived at the accident site. As an immediate task, it was asked to clear press boats, which were blocking sea room and jamming sonar. The SUPSALV representatives were then transferred to the VOYAGER by helicopter for conference. Shortly thereafter, repairs to PISCES II's manipulator were completed and it was launched; but it had to be recovered almost immediately, due to an

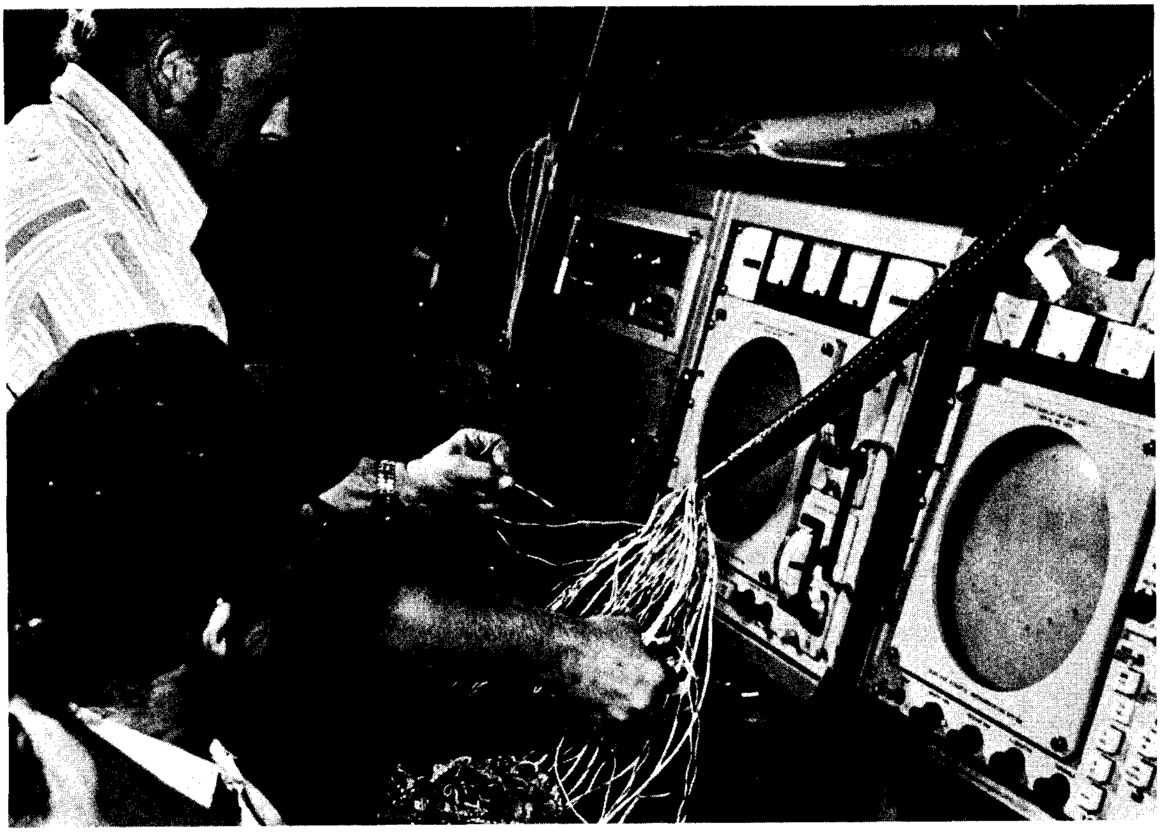
VICKERS VOYAGER, in distance, is directing preliminary bottom operations for PISCES II and PISCES V.

CANADIAN COAST GUARD CUTTER WITH CURV ABOARD AT ACCIDENT SITE

engineering flooding emergency. Operations immediately went ahead to employ CURV, despite the worsening weather: 45 knot winds, gusts to 50, and up to 20 foot seas. With darkness falling and the force helicopters (not equipped for night flying) out of fuel, the SUPSALV team was put to the unenviable task of returning to CABOT in the British GEMINI pneumatic rubber boats, at night. They brought with them the second toggle fabricated by Vickers, for CURV to insert into PISCES III to permit its raising.

CURV Difficulties

CURV, now, was subjected to its own difficulties by the sea conditions, when green water came aboard the CABOT and shorted-out CURV's primary 56-pin electrical power



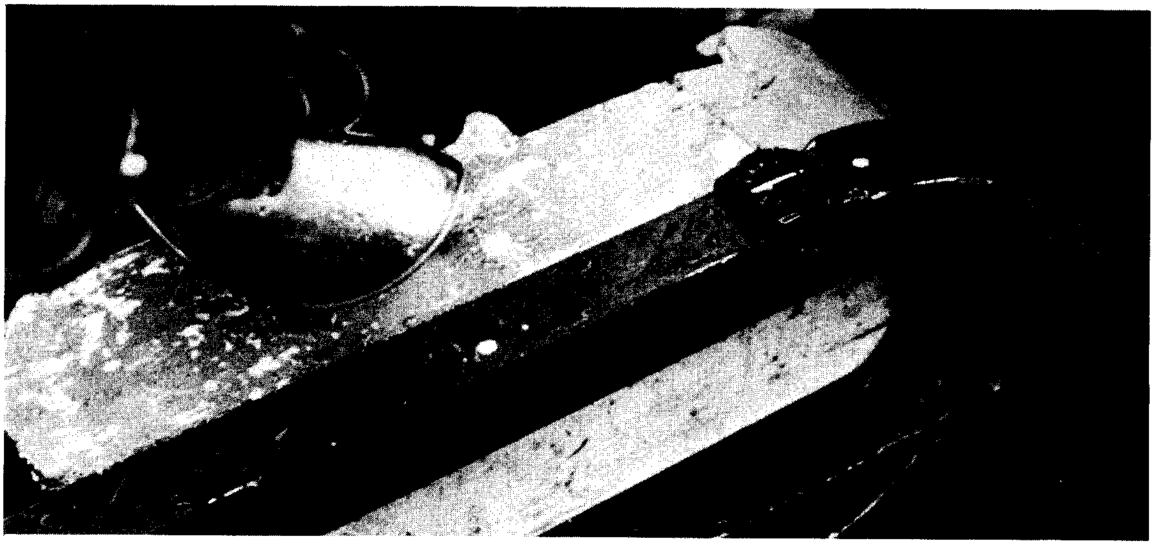
When green water came aboard CABOT and shorted-out CURV's primary 56-pin connector, repairs were pushed through in record time.

EQUIPMENT DIFFICULTIES WITH CURV WERE QUICKLY DEALT WITH

and control connector. Repairs were pushed through in record time. In addition, a gyro failure was imaginatively and effectively circumvented by the field expedient of strapping a diver's wrist compass onto CURV's carriage where it could be read by one of the TV cameras.

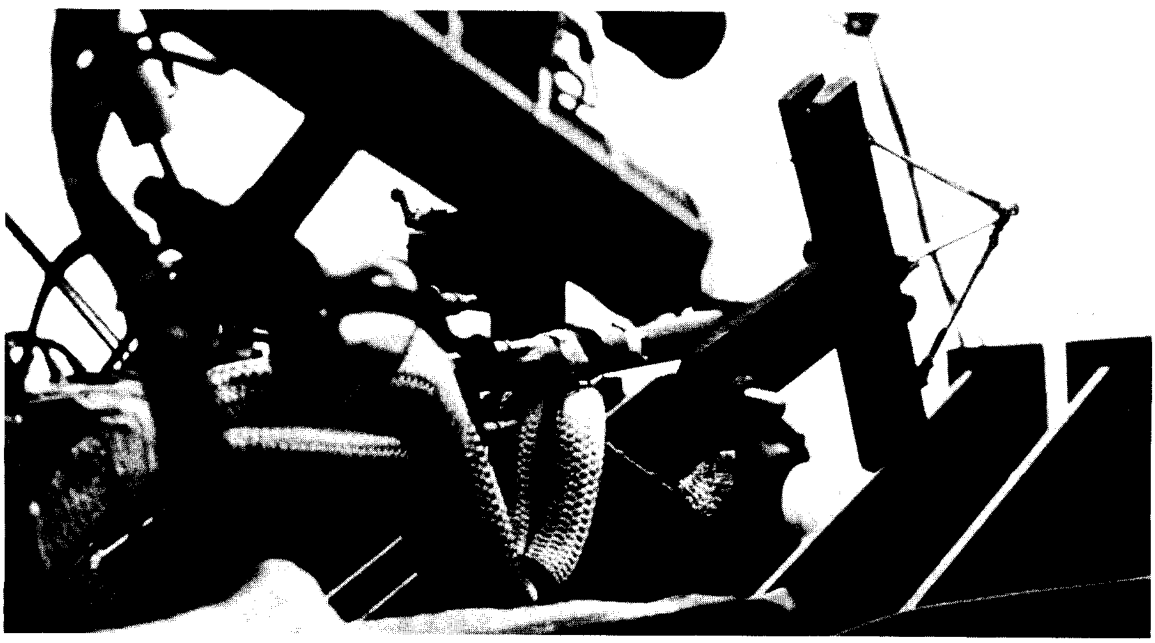
PISCES II Attaches First Rescue Toggle

PISCES V then had to be recovered for battery charging (after dropping a sonic pinger device down PISCES III buoy line), and PISCES II was relaunched with the other rescue



A gyro failure was imaginatively and effectively circumvented by strapping a diver's wrist-compass onto CURV's carriage where it could be read on the closed-circuit TV cameras by operator.

NAVIGATIONAL FIELD EXPEDIENT FOR CURV



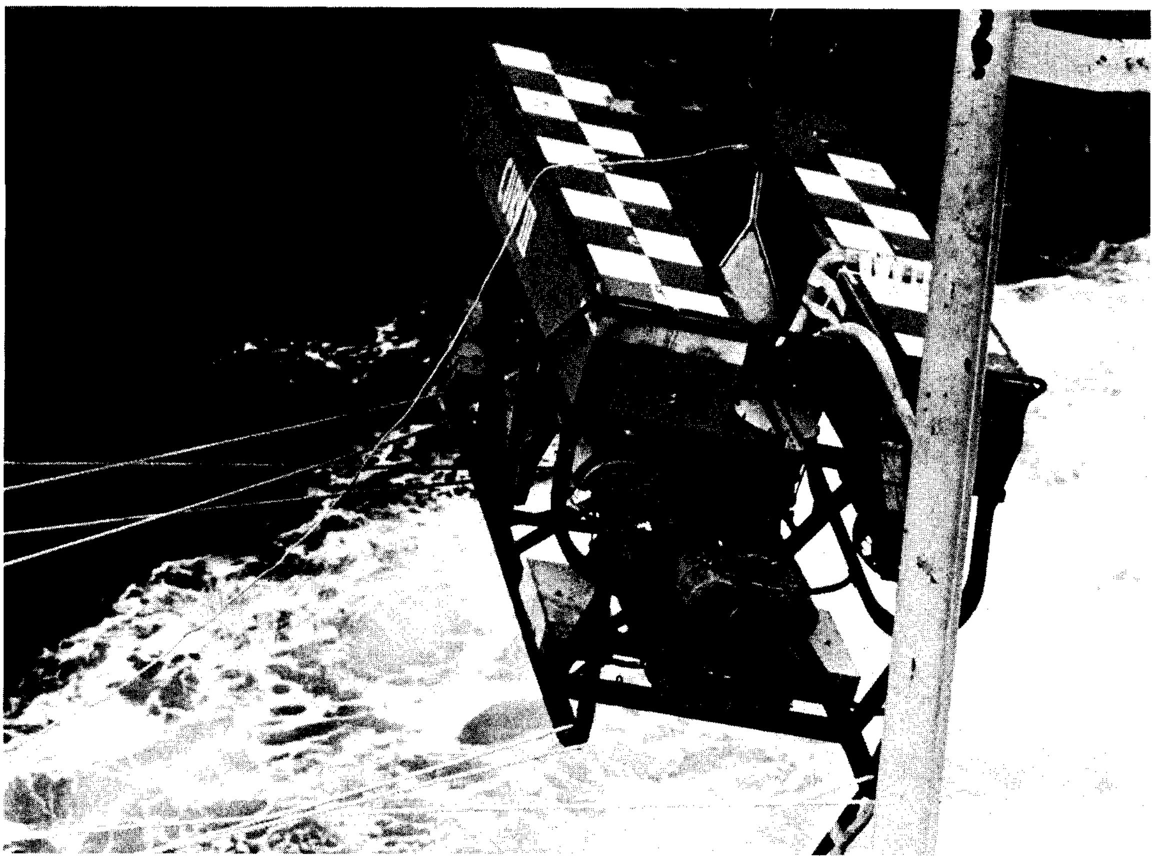
CURV was launched carrying the second special lifting toggle, fabricated by Vickers for the rescue, for insertion into PISCES III's open after hatch. Secured to the toggle is the 6-inch braided nylon line, which has a breaking strength of 50 tons.

SPECIAL LIFTING TOGGLE IN CURV'S MANIPULATOR

toggle and a light, 3.5-inch polypropylene line. PISCES II was able to successfully emplace this toggle in PISCES III's 14-inch open hatch as a starting maneuver, but the 3-1/2 inch polypropylene was considered too weak as a sole source of lift.

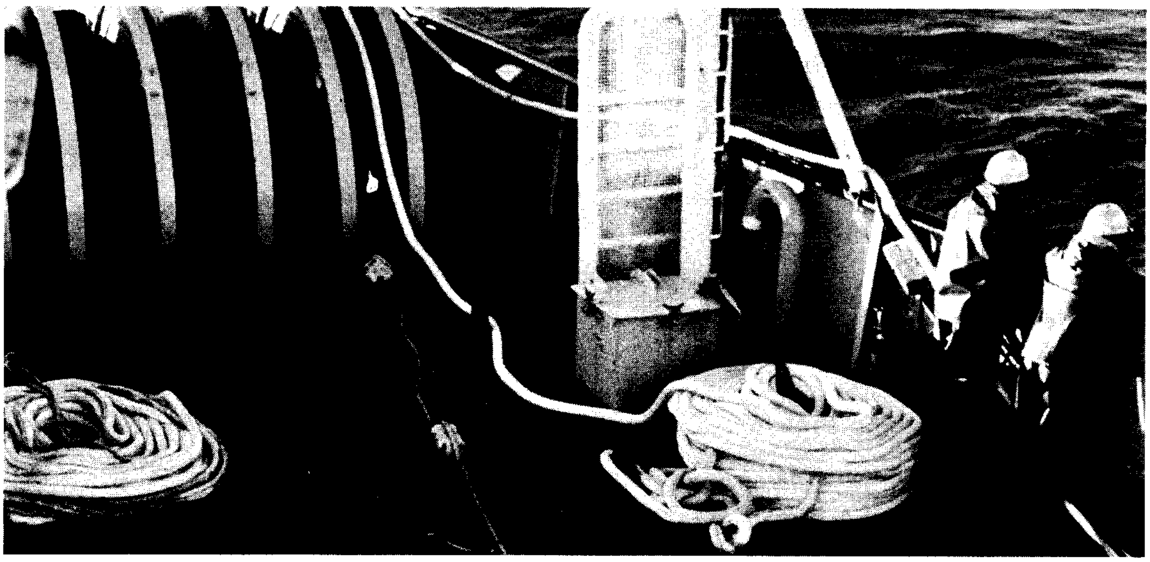
Deployment of CURV

Its repairs completed, CURV was launched. It carried a 6-inch braided nylon line, with a breaking strength of 50 tons, secured to the toggle with which the CURV team had been



CURV BEING LAUNCHED FROM THE CANADIAN COAST GUARD CUTTER JOHN CABOT

provided by Vickers. Using its underwater TV with coupled lights to observe the makeshift compass, the surface operator guided CURV III while it made its descent under the rough seas.



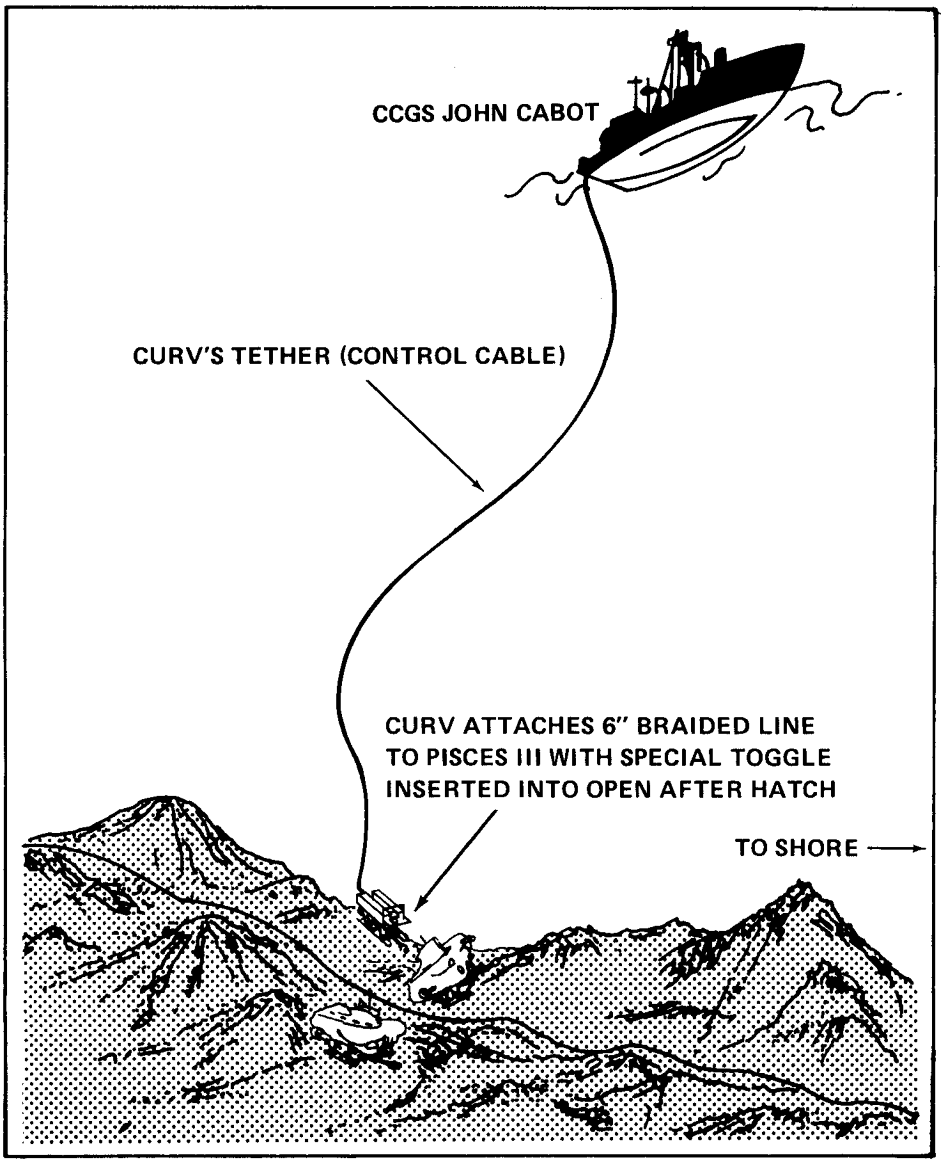
The buoyed power-control umbilical of CURV lays across the focs'l. Together with the 6-inch braided nylon line attached to the lift toggle, held by CURV for the rescue, it is fed over the side over one of the JOHN CABOT's bow sheaves.

SUPSALV representatives discuss the rescue operations in progress as CURV descends to attach lifting toggle for raising PISCES III.

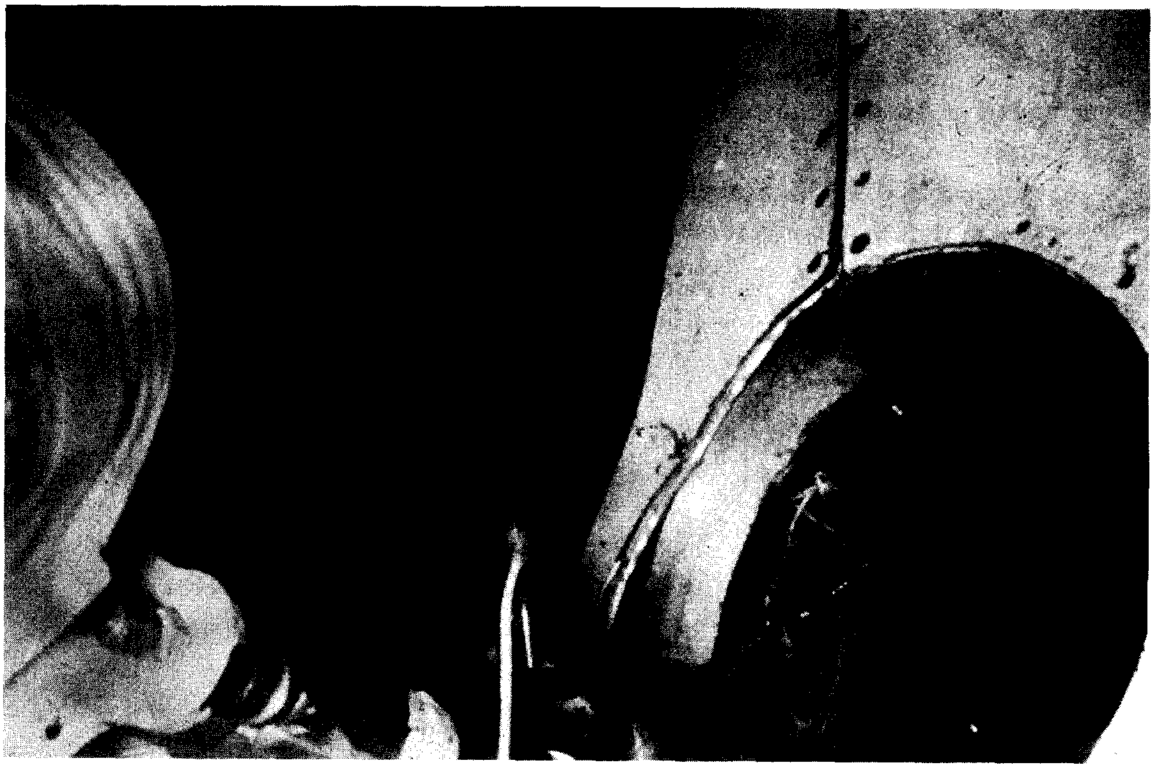
ABOARD THE JOHN CABOT

SUCCESSFUL RESCUE

In a little under 40 minutes CURV had swum to depth. The stranded minisub acted as a sonar target and within an hour after launch CURV III was positioned only 250 yards from the downed PISCES III. It then required about 10 minutes to home-in on PISCES by sonar, and less than 5 minutes to successfully insert its toggle in the open 14-inch after



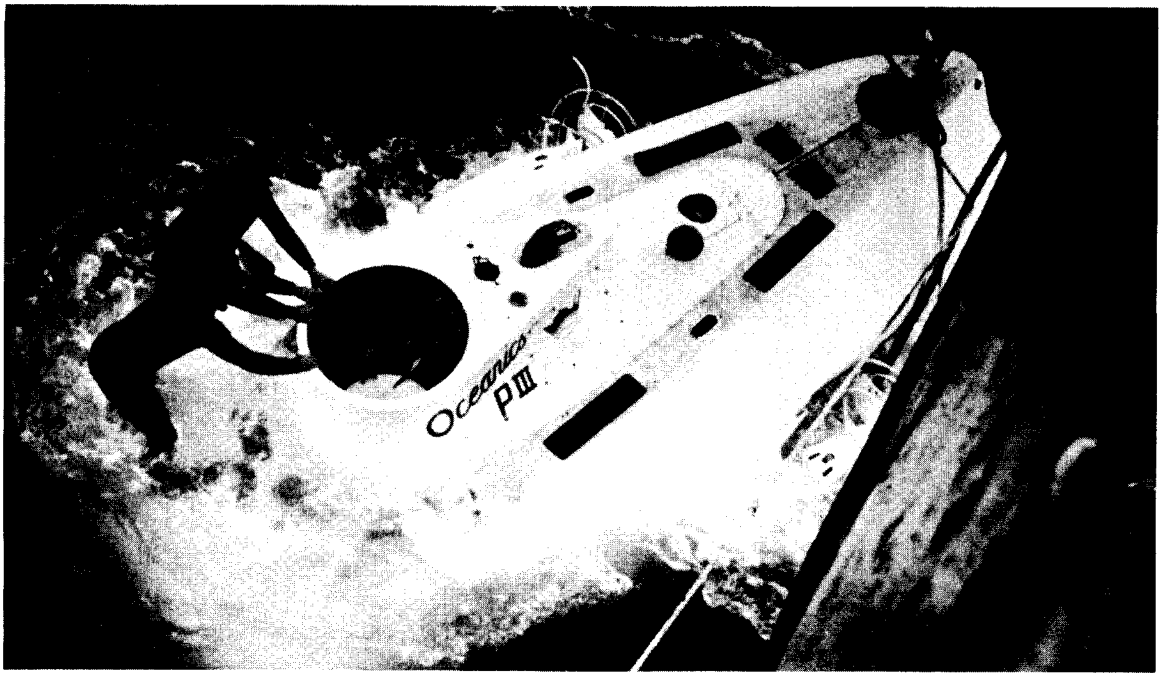
CCGS JOHN CABOT AND CURV ATTACH LINE TO PISCES III



Using the manipulator on the front of CURV and observing the operation in the TV screen, as seen above, the CURV operator quickly installed the lifting toggle with rescue line attached.

CURV PLACING LIFTING TOGGLE INSIDE PISCES' OPEN AFTER HATCH

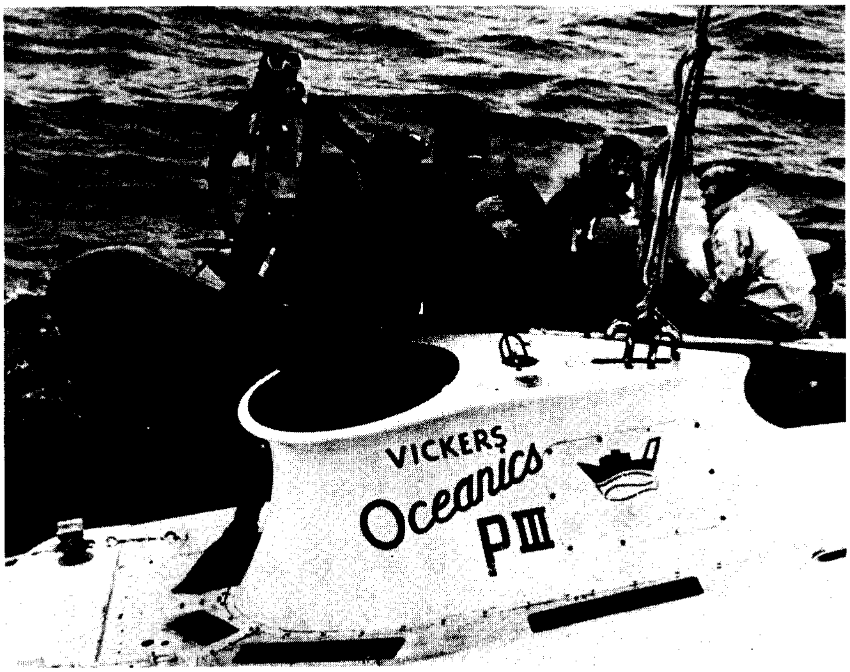
hatch. After CURV III was backed away to test the strength of the line, CABOT commenced lifting PISCES III, using the two lines inserted into the submersible. It proceeded satisfactorily but slowly; the rate of ascent was approximately 60 to 100 feet per minute. When their lines entangled, CURV III was abandoned and cut loose from the rising PISCES III to ensure the latter's safe recovery. Divers were in the water waiting when the disabled sub reached 60 feet, to attach another line to PISCES III, stabilizing it against the rough seas. After about two and a half hours, PISCES III was lifted clear of the water, and the two crewmen, safe and well after their 76 hour ordeal, were moved to the VICKERS VOYAGER by rubber boat. PISCES III, also, was subsequently hauled aboard VOYAGER.



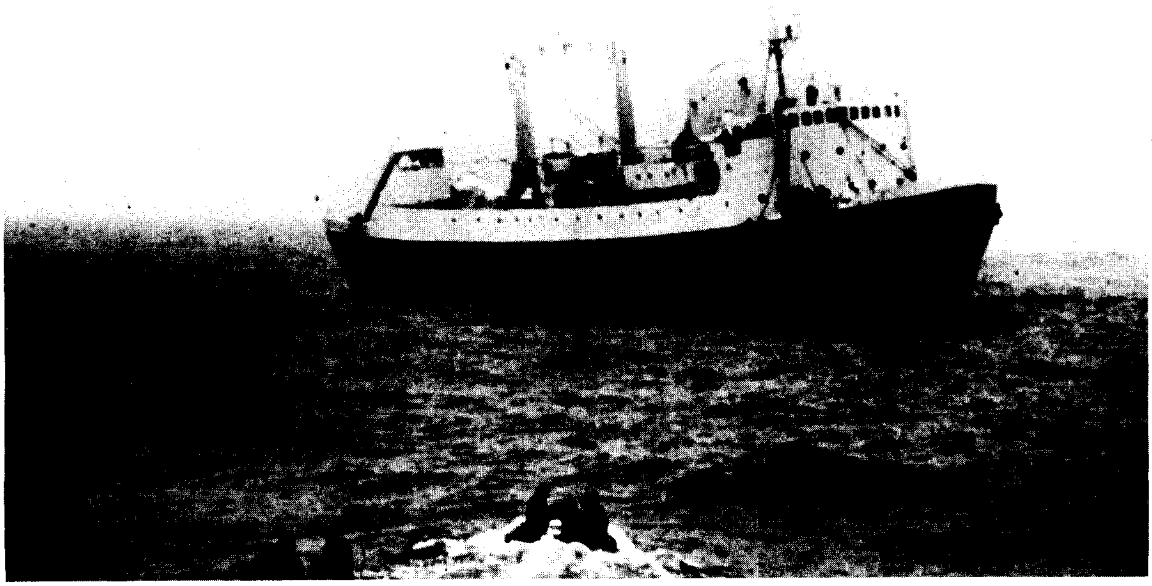
PISCES III breaks surface alongside CABOT. Note toggles and two lines lifting at after hatch. Divers are already aboard to assist crew out of the submersible.

Divers assist first crewman from hatch of PISCES III

SUCCESSFUL RESCUE OF PISCES III AND CREW



First crewman from PISCES III is assisted into a GEMINI rubber boat. Note that additional lines from CABOT have been attached to main lift point of PISCES.



Crewmen of PISCES III are returned safely to the VICKERS VOYAGER after 72-hour ordeal trapped at 1,600 feet. PISCES III was towed back after flotation gear was attached.

SAFE RETURN OF CREW

CONCLUSIONS

The successful rescue of PISCES III and its 2-man crew can be attributed to the substantial deepwater working capability of CURV and its operators, and to the efficient design and logistic arrangements that enable the CURV system to be installed and operable, aboard a non-U.S. ship, 6,000 miles from home base, in a little over 24 hours.

It is interesting and important to note that breakdown in various elements of the rescue resources mobilized by Vickers typifies the unforeseen difficulties inherent in marine disasters. Moreover, a major lesson in dealing with deep sea rescue is to be learned from noting all the successful technical and logistical arrangements laid on by Vickers. In particular, the deep backup redundancy proved, rather than excessive, to be ultimately crucial to success. Special equipment was quickly prepared in duplicate. Many organizations and resources were successfully coordinated. A wide variety of land, sea, and air logistics were efficiently mobilized. Ships, deep submersibles, technicians, and operations experts were moved into the incident site.

A less obvious but important element of the rescue was attributable to the pilot and observer of the sunken PISCES III. As a result of successful training and operations, they were able to conduct themselves efficiently and effectively, with no panic or waste of life support.

Overall, the rescue constituted a prime example of international cooperation in rescue and salvage at sea. Naval and commercial elements of Canada, England, and the U.S. coordinated with gratifying results: two men and a valuable submersible were recovered in good condition from deep ocean bottom. Lastly, CURV was again proven to be an excellent part of our search and recovery equipment pool.

PROMPT, ECONOMICAL UNDERWATER REPAIRS TO USS F. D. ROOSEVELT (CVA-42)

On two occasions during 1973, it was necessary to undertake emergency repair on the ROOSEVELT. The first occasion involved rebuilding a portion of a severely damaged rudder. The second occasion was necessitated by the need for replacement of a propellor-shaft gland. In both cases, the work was undertaken by divers working underwater, using special techniques. The capability to accomplish such work in this fashion successfully circumvented expensive and time-consuming diversion to a drydock.

USS F. D. ROOSEVELT (CVA-42)

PROMPT, ECONOMICAL UNDERWATER REPAIRS TO USS F. D. ROOSEVELT (CVA-42)

INTRODUCTION

Twice in 1973, emergency repairs were provided for the USS F. D. ROOSEVELT (CVA-42) by means of rapid and effective underwater techniques. In both cases time consuming and expensive diversion to a drydock was circumvented.

In December 1972, ROOSEVELT returned to Mayport, Florida, with a severely damaged port rudder.

Diver's inspections, employing UDATS, the Underwater Damage Assessment TV System, revealed that welds at the top of the rudder had failed. Underwater inspections confirmed that a new transverse bulkhead and a flanged cap plate would first have to be fabricated for the rudder. They then could be installed underwater by divers. The new bulkhead was installed first and the replacement cap plate was then slid into the 2-inch clearance between the rudder skeg and the rudder and fitted into place. Divers had to then drill and tap 130 bolt holes in the rudder plate. When all the securing bolts were torqued down, an underwater epoxy was used to provide a watertight fairing of the cap plate to the rudder.

Again, in May 1973, SUPSALV provided contractor diving services for repairs to the ROOSEVELT. In this case, underwater work was required to close all openings to the sea in the stern tube of #3 propeller shaft so that the shaft's inboard stuffing box, which normally seals out the seawater, could be opened up to have its packing replaced. This quick, successful repair job was completed by a single diver and tender in only two days.

These two different repair efforts illustrate several new and useful techniques for effecting ship repairs underwater, promising great savings in time and money over the conventional method of repairing in drydock.

REPAIRS TO RUDDER – JANUARY 1973

Rudder Damage Assessment

At the end of a 10-month deployment in the Mediterranean, at the end of 1972, the 63,000-ton ROOSEVELT returned to its base, U.S. Naval Station, Mayport, near Jacksonville, Florida, suffering from undiagnosed port rudder problems.

Since drydock facilities are not available in the Jacksonville area to take the carrier out of the water for conventional repair techniques, the Supervisor of Shipbuilding, Jacksonville (SUPSHIPSJAX) called the Supervisor of Salvage (SUPSALV) to determine the feasibility of underwater repair. The Taylor Diving and Salvage Company was then engaged to perform the work, with a SUPSALV Representative on-site, providing direction and technical assistance. Inspection, using the Underwater Damage Assessment TV System (UDATS), revealed a loose top plate of the rudder shell, caused by failure of welds at the upper edge of the lower balance section of the rudder. This partially detached plate was jamming against the rudder skeg, in the narrow clearance between the balance section of the rudder and the bottom face of the skeg.

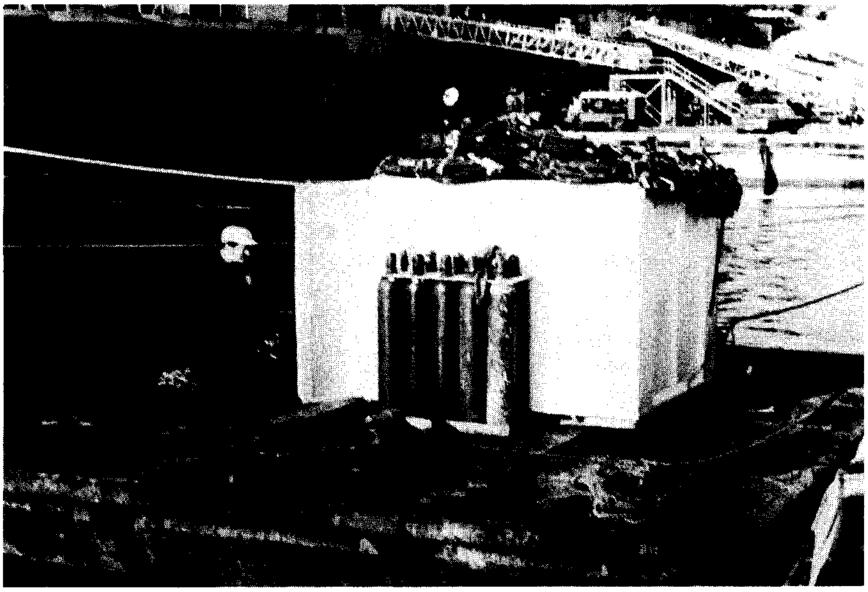
The normal procedure in making a repair of this nature would be to drydock the ship at a minimum cost of $100K and drop the rudder. Since the only Navy drydock for carriers on the East Coast is at Norfolk, and was not available at the moment, SUPSHIPSJAX decided to see if the repairs could be made at pierside at Mayport. SUPSHIPSJAX called upon SUPSALV to provide technical assistance in determining whether the repair was feasible. This done, planning conferences were held over the Christmas holidays, and a plan was developed by which the structural integrity of the rudder could be restored, provided that the main casting was not cracked. Whether the casting to which the plate was welded had cracked, or whether further internal damage existed, could not be determined without dismantling the rudder.

UDATS Underwater Damage Assessment TV System

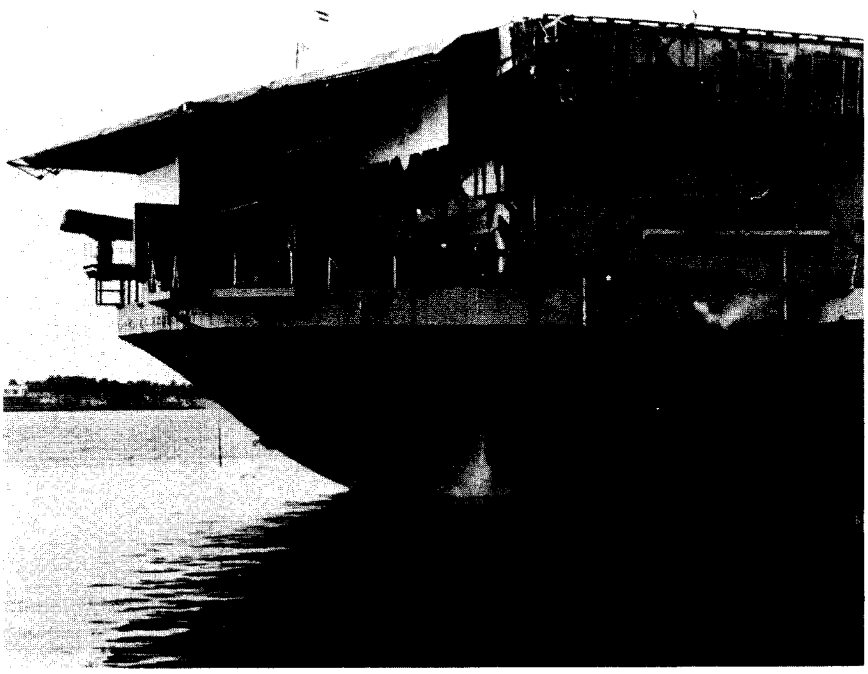
UDATS permits a diver to provide as detailed a survey of a ship's underwater hull and fittings as can be made visually in drydock – better under some conditions. The diver uses a portable underwater TV camera, complete with integral underwater lighting source, to survey any underwater portion of the ship. A ship repair technician at the video display can monitor and directly supervise the survey using the diver's underwater telephone system. The results can also be recorded on video tape for subsequent, repeated viewing by interested persons. The UDATS survey was essential to quickly evaluate the extent of the damage to the ROOSEVELT's rudder. By means of UDATS it was ascertained that underwater repairs were feasible.

Preparation for Repairs

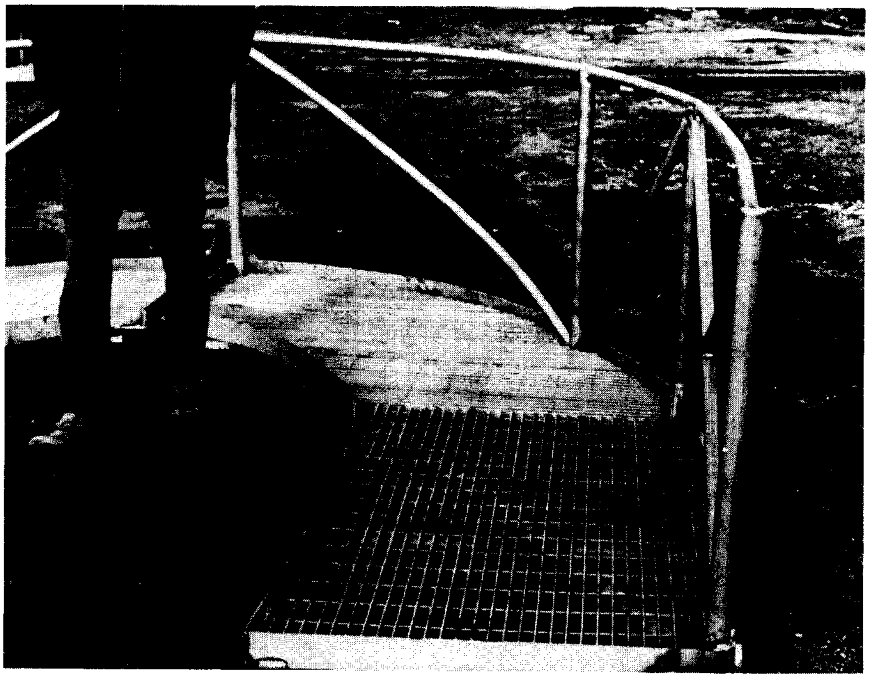
A diving platform was set up, on a pontoon barge, under the fantail of the ROOSEVELT. Initially, the divers set up a hogging line on the rudder and installed an



The pontoon barge, above, was moored under the ROOSEVELT's stern, shown below. It was used to rig an underwater stage on the leading edge of the damaged rudder, as well as a supply and work platform throughout all repairs.



WORK PLATFORM FOR ROOSEVELT REPAIRS



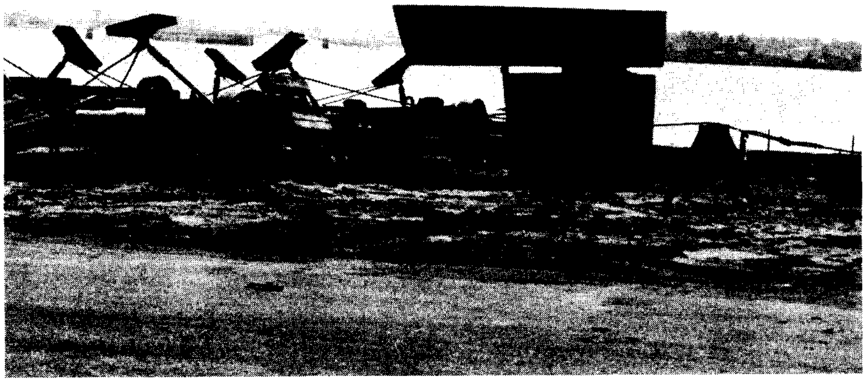
Aluminum work stage fabricated and mounted on the leading edge of ROOSEVELT's rudder to provide a working base for divers repairing the rudder.

UNDERWATER WORK STAGE

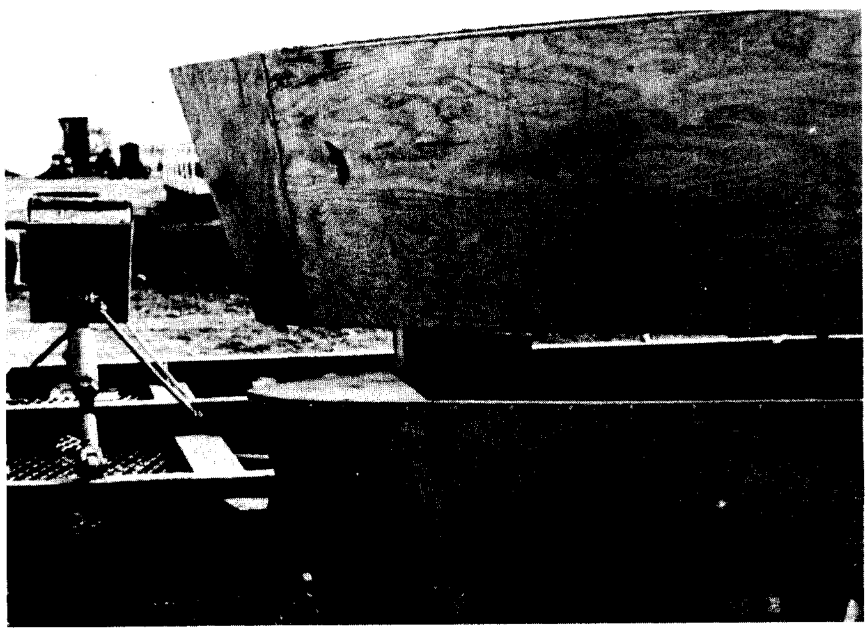
aluminum stage on the upper forward part of the rudder. The time and effort put into building the stage were well spent, since this catwalk around the rudder became the stable platform from which most of the work was done. In order to assist the divers, who would be working in 50°F water with near zero visibility, a plywood mockup of the rudder was constructed and placed on the pier where the ROOSEVELT was moored. This enabled the divers to familiarize themselves with the rudder's structure, and established better understanding among the topside engineers, divers, and supervisor involved in the job.

Preliminary Work and Planning

Using oxy-arc cutting equipment, the divers then removed the horizontal plate atop the rudder where welds had failed. With the top plate removed, a thorough inspection of the inside and outside of the rudder was performed. Inspection revealed that the upper two feet of the transverse bulkhead, inside the rudder, had fractured and separated. The rudder was large enough to accommodate divers to work inside it to install a new section of bulkhead.



An accurate plywood mockup of ROOSEVELT's rudder was made to familiarize divers with their underwater job and to facilitate understanding between them and repair technicians.



WOODEN MOCKUP OF ROOSEVELT'S RUDDER

When ultrasonic testing revealed that there were no cracks in the main casting, the decision was made to proceed with the repair work with the ship in the water.

The plan adopted was to manufacture and install a new transverse bulkhead and flanged cap plate, complete with all bolt holes. Threads would be tapped in the rudder shell, and flathead bolts would be used to fasten the new parts. Underwater welding was considered not feasible because of the Special Treatment Steel (STS) of which the rudder was constructed. Because of the precision fit required on the cap plate and the bulkhead, templates and jigs were made up that allowed the compound curves and angles from the rudder to be transferred to the pieces under construction.

Sequence of Repairs

From inside the rudder, divers drilled and tapped holes on the inside of the rudder shell, to receive bolts that would secure the new bulkhead section. After the bulkhead was installed and repair engineers had inspected the installation, using UDATS operated by the divers, preparation was made for installing the 1,050-pound cap plate between the skeg and the rudder. The cap plate was installed using chain falls and wire, run beneath the ship between the rudder and the propellers. There was no way of attaching buoyancy to the cap plate to lighten it for handling by the divers, because of close quarters in the installation – the clearance between the top of the rudder and the rudder skeg above it was only 2 inches. The first attempt at installation revealed that the cap plate would have to be brought back to the surface for some changes. When installed the second time, a near perfect fit was achieved, with no more than .125 of an inch clearance at any one point.

With the cap plate in place, the divers began the job of drilling and tapping over 100 holes in the side of the rudder to receive 1/2-inch, flathead bolts. (The holes in the cap plate, itself, had been pre-drilled and countersunk in fabrication.) The drilling operation proved to be very difficult because of the hardness of the rudder shell plate and the extreme hardness of heat-affected zones from prior welding. A special drill press was set up, clamped between the cap plate and the skeg above it, with hydraulic fingers, after a pilot bit was aligned with the holes. In this way the divers were relieved of maintaining the drill at the correct angle, and instead they could concentrate on the difficult task of feeding the brittle, carbide-tipped drills into the hard steel without breaking them. With the pilot holes drilled, enlarging the holes to tap size and tapping the threads was easier.

In installing the plate fastening bolts, it was discovered that Locktite thread locking

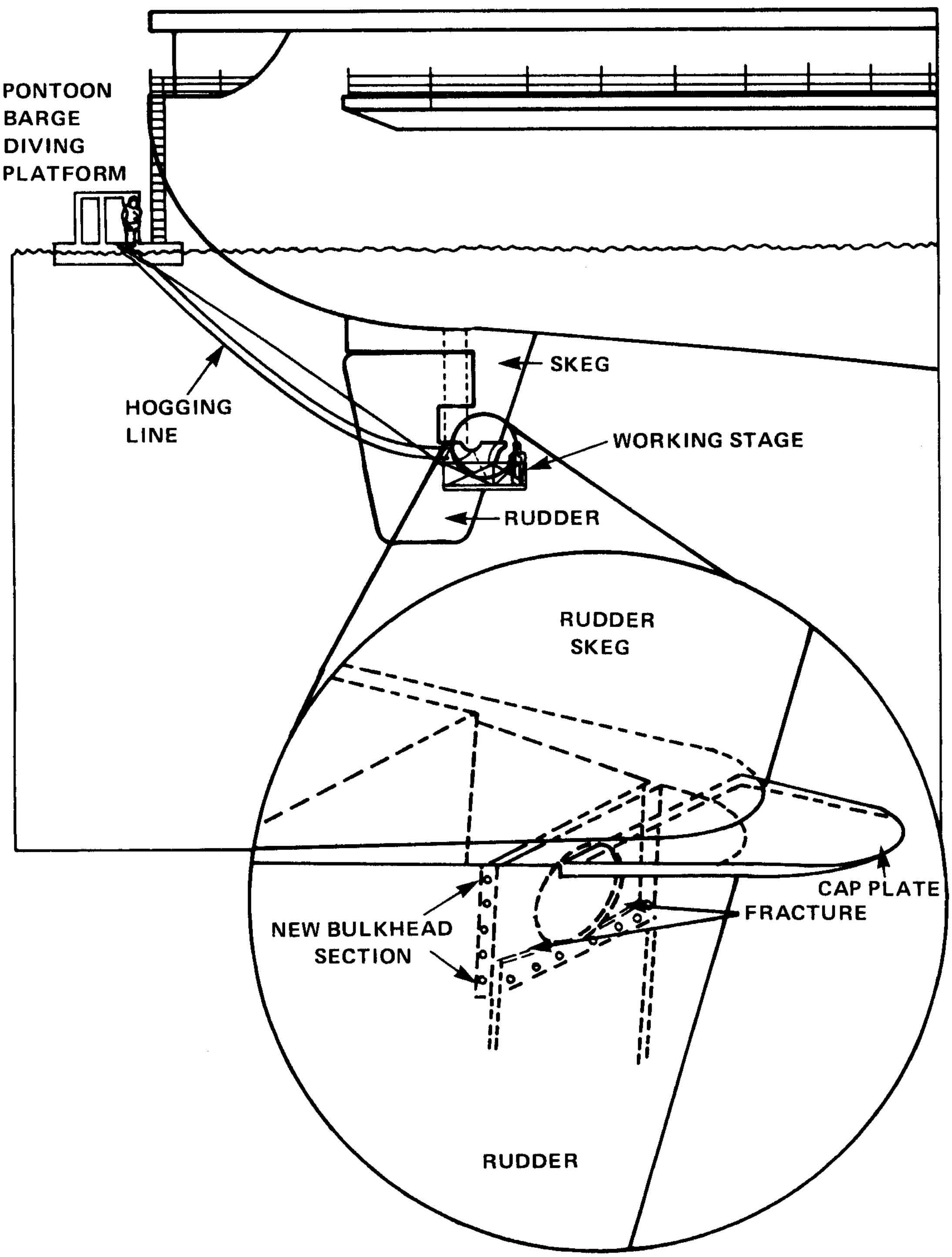
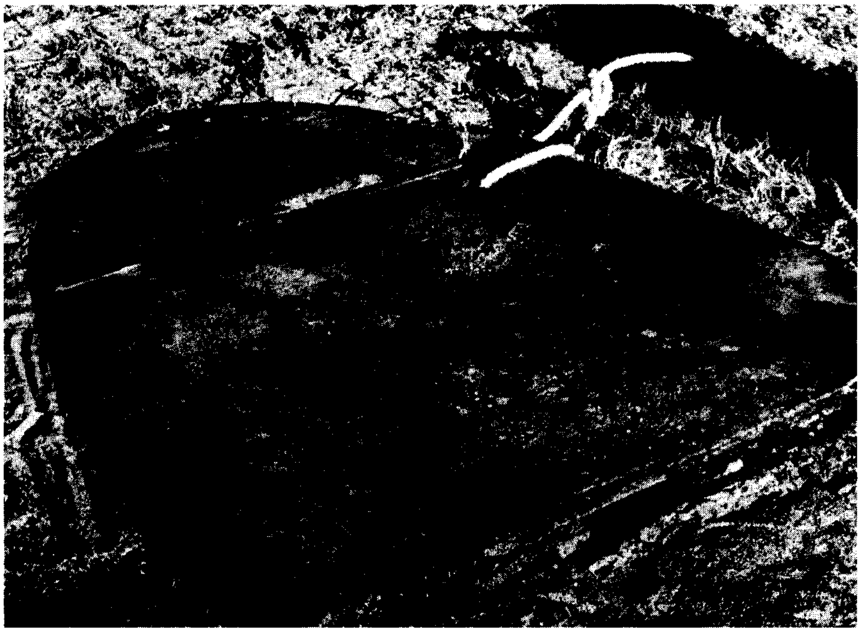


Diagram of underwater working setup for repairs to rudder of USS F.D. ROOSEVELT (CVA-42) and details of repaired section and repairs.

USS F.D. ROOSEVELT RUDDER REPAIRS



This plate was precut, but not yet drilled for bolt holes, to replace that portion of the ROOSEVELT's rudder which had been torn loose. It was lowered from the diving platform by chainfall and worked into the narrow clearance between the rudder top and rudder skeg and bolted in position.

REPLACEMENT RUDDER CAP PLATE

compound worked well under water and it was used to lock the cap plate bolts into the rudder shell. When all the bolts were torqued down, an underwater epoxy was used for fairing the cap plate to the rudder.

REPAIRS TO PROPELLER SHAFT – MAY 1973

Leaking Shaft Gland

In May of 1973, it became necessary to undertake repairs to the ROOSEVELT's #3 (port inboard) propeller shaft. The work involved removing and replacing the packing of the stuffing-box gland, which keeps out the seawater where the propeller shaft pierces the rear of the shaft alley. Because flooding of the shaft alley is an immediate consequence of removal of the gland or its packing, this job is usually done in drydock. Again in this case, as with the repairs to the ROOSEVELT's rudder, it was deemed possible to circumvent the difficulties and expense of docking, by proper underwater repair techniques. The Supervisor

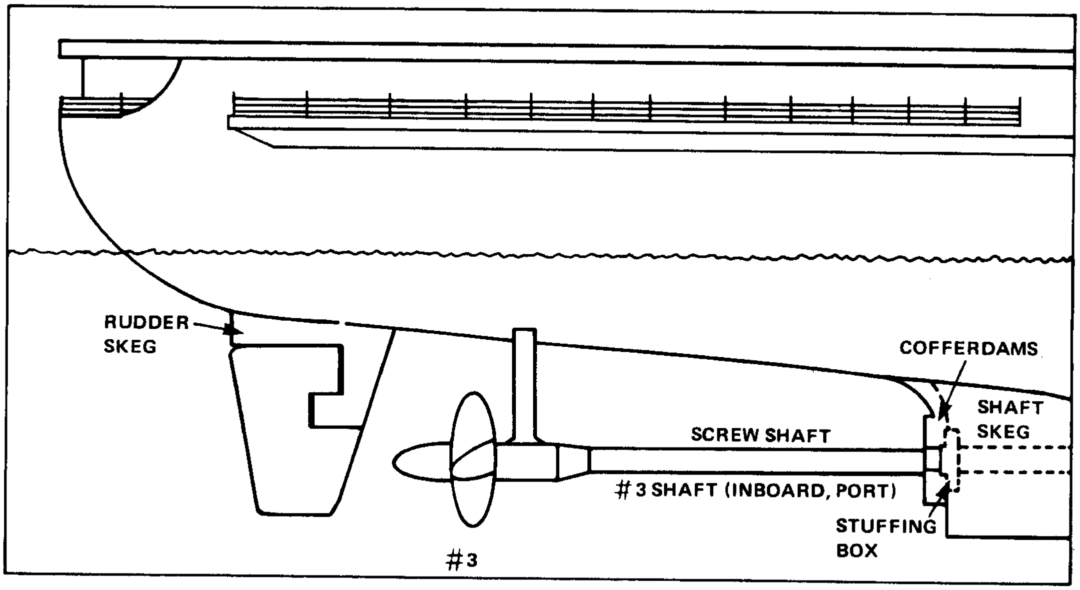


Diagram of cofferdam installation on #3 shaft of USS F.D. ROOSEVELT (CVA-42), showing location of cofferdams at the outboard face of the shaft skeg to hold out water from the stuffing box gland to permit replacement of packing.

REPAIRS TO ROOSEVELT'S PROPELLER SHAFT

of Salvage, in response to the request from Commander, Naval Air Forces, Atlantic Fleet, provided contractor services from the Harter Underwater Corporation to do the job.

Repair Procedure

The divers first emplaced a pair of patches over the bearing intake ports and formed a seal with rubber tape at the point that the propeller shaft emerged from the stern tube. Water, however, could not be drained from inside the stern tube so that the inside stuffing box could be opened. Deterioration in the skeg and the stern tube had created pinhole leaks that caused the stern tube to continue to flood. By installing two portable eductors, powered by firemain pressure on the bearing intake port patches, water flowing into the stern tube from the pinhole leaks could be diverted back to the sea. These arrangements kept the sea from flooding the shaft alley so that the inside packing gland could be dismantled and the packing rings replaced. The work proceeded satisfactorily and was completed in two days.

CONCLUSIONS

The current state-of-the-art in underwater repairs is permitting more and more in-water repairs. These two repairs to the ROOSEVELT are typical.

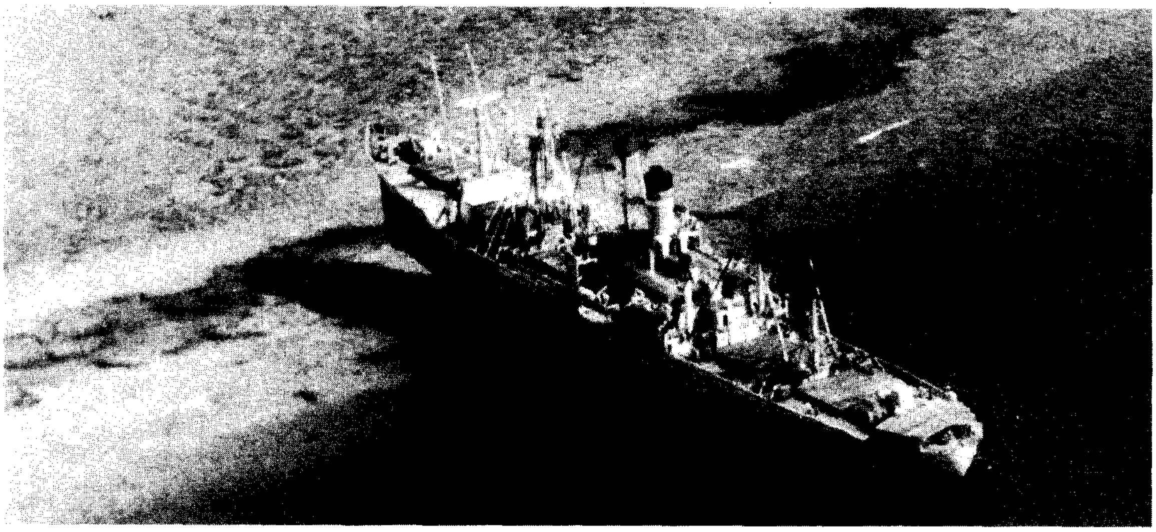
Particular attention is being given by repair facilities to the use of UDATS. This system greatly extends the expertise of repair facilities in underwater work. It eliminates dependence on a diver's eyes and personal skill in evaluating underwater repair requirements, and provides for a careful survey and video record of any underwater structure. Any technician who may be involved can not only have access as required to repeated video display using video tape, but can as well specify the type and areas of survey to be made.

The successful and timely repairs of the ROOSEVELT's rudder and packing gland meant great savings in time and money over the conventional method of repairing in drydock, and without disruption of the ship's operating schedule. It provided valuable alternatives, given today's difficulty in providing available drydocks and the high cost of their use.

SALVAGE EFFORTS AND

STRIPPING OF

USNS SGT. JACK J. PENDLETON (T-AK-276)



PENDLETON went aground on this coral reef in the Paracels, South China Sea. Although unholed and relatively undamaged, crucially heavy, unloadable cargo over the point of grounding defeated simple retraction operations.

USNS PENDLETON AGROUND ON TRITON ISLAND REEF

Before adequate salvage resources could be brought to bear, typhoons NORA, OPAL, PATSY and RUTH, in quick succession, broached PENDLETON 70 yards onto the reef.

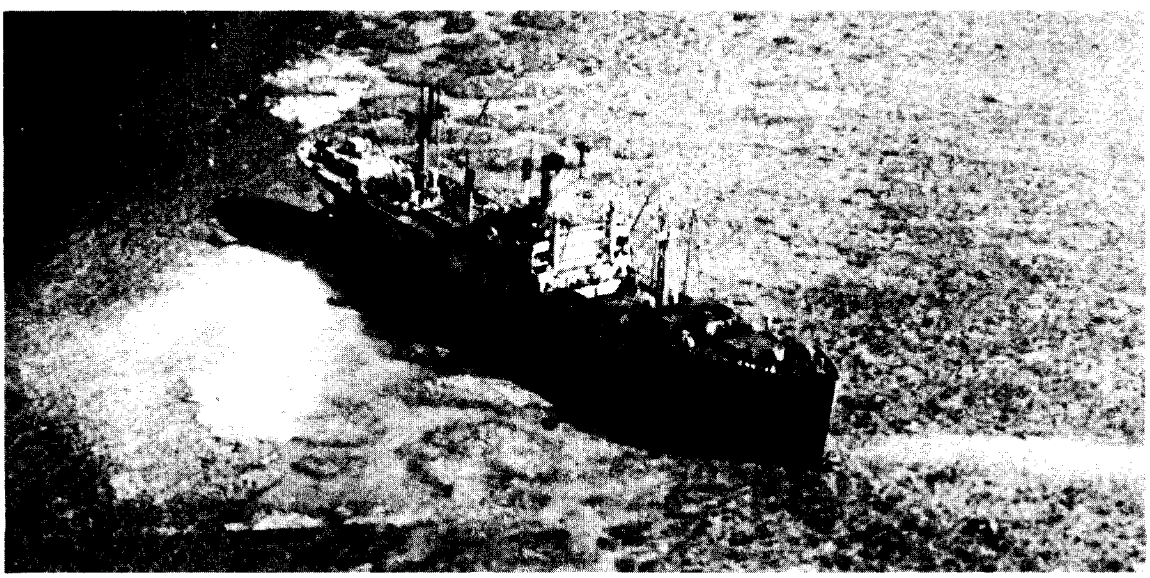
TYPHOON BATTERS PENDLETON

SALVAGE EFFORTS AND STRIPPING OF USNS SGT. JACK J. PENDLETON (T-AK-276)

INTRODUCTION

On the morning of 25 September 1973, the USNS SGT. JACK J. PENDLETON (T-AK-276), en route from Southeast Asia with a cargo of old ammunition and generators, ran aground on Triton Island in the Paracels. The salvage ship USS BEAUFORT (ATS-2) was immediately dispatched to the scene, and commenced efforts to refloat the stranded vessel. It quickly became evident that the task would require more than the efforts of one ship. The salvage effort was soon augmented by the arrival of the USS HITCHITI (ATF-103) and the USS RECLAIMER (ARS-24), as well as several other auxiliaries.

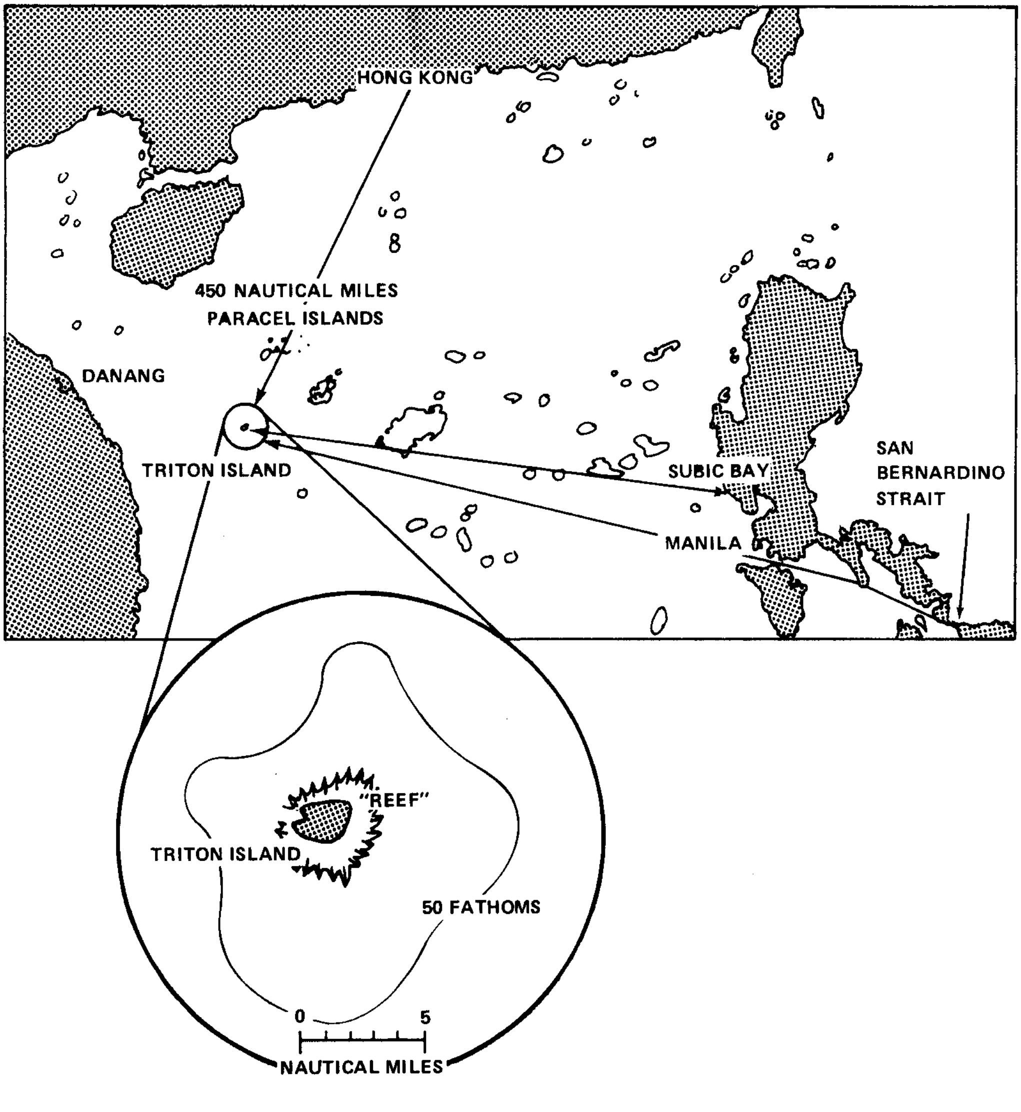
Preparations continued, including the removal of cargo and ballast, the shifting of fuel, and the rigging of beach gear. Cargo offloading progressed at a painfully slow rate because of the deckload on PENDLETON's crucial hatch to hold 2 which was too heavy for the equipment available. Although several unsuccessful retraction attempts were made with decreasing loads, the chances of success still looked good when operations had to be



After the typhoons, salvage was limited to unloading cargo, stripping ship of all valuable gear, and transferring fuel oil to prevent marine pollution.

PENDLETON DECLARED A LOSS

suspended due to the imminence of typhoons. During the following two-week period from 5 to 20 October, four typhoons passed through the area, during which PENDLETON was broached-to and driven 70 yards further onto the reef. Inspection of the vessel then revealed her to be wrecked beyond economical salvage, and the decision had to be made to remove all cargo and valuables and abandon the wreck. All efforts, including removal of oil, were completed by 6 November.



PENDLETON GROUNDED ON TRITON ISLAND IN THE SOUTH CHINA SEA

CIRCUMSTANCES OF GROUNDING

The USNS SGT. JACK J. PENDLETON (T-AK-276), en route from South Vietnam, ran aground on the coral reef of Triton Island (15°47'06" North, and 111°11'30" East) in the Paracel Islands, on the morning of 27 September 1973. The seas at the time were flat, calm, and the tide was at its monthly high.

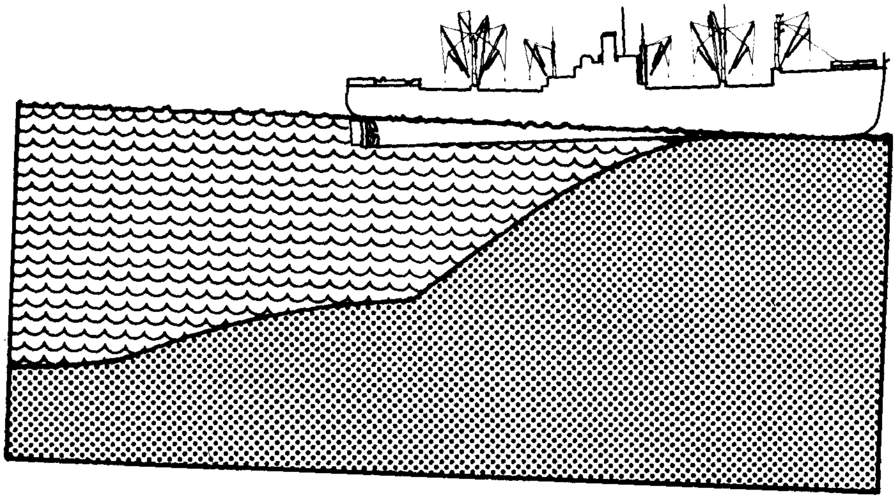
At the time of the grounding the PENDLETON was making 17.5 knots. The force of this speed drove the vessel aground on the coral for approximately 1/3 of her length, from frames 75 forward to frame 37. (Subsequent photographs show the bow a full four feet out of the water.) Damage, nevertheless, was minimal: the hull suffered only minor deformation, all tanks were tight, and machinery and electrical systems were operational.

The PENDLETON was a general cargo ship with light-ship-displacement of 4,716 tons. At the time of her grounding, her displacement including cargo was 10,300 tons. Cargo was comprised of 2,007 tons of palletized 105mm ammunition, and 257 tons of heavy generators and their associated switching equipment. This cargo distribution is outlined in Table 1.

TABLE 1 – DISTRIBUTION OF CARGO

Location	Weight	Material
Hatch 2	100 tons	Two Generators
Upper Tween 2	57 tons	Generator Switch Equip.
Hold 2	231 tons	105mm Ammunition
Lower Tween 3	331 tons	105mm Ammunition
Hold 3	768 tons	105mm Ammunition
Upper Tween 4	108 tons	Two Generators + Aux. Equip.
Hold 4	464 tons	105mm Ammunition
Hold 5	213 tons	105mm Ammunition

In addition, liquid loading consisted of 2,882 tons of fuel oil and seawater ballast (9,180 barrels of NSFO/#6 Fuel Oil and 1,523 tons of seawater ballast), and 430 tons of fresh water. PENDLETON's draft prior to grounding was 16 feet forward and 24.6 feet aft. After striking the reef, the forward draft was a minus 4 feet, while the after draft increased to 32 feet. Initial calculations indicated the PENDLETON's ground reaction on the crushed coral at 3,160 tons at high tide, with an increase of 685 tons per foot of tidal drop.



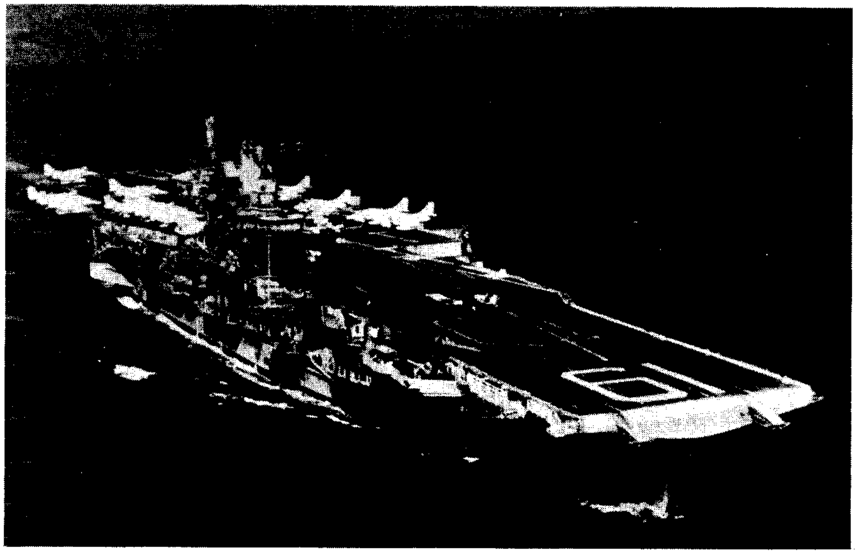
PENDLETON was aground, in contact between Frames 40 and 50, approximately 110 feet abaft the bow. With fuel transfer aft and deballasting, she trimmed with a 32-foot draft astern and the bow 4 feet out of water.

DIAGRAM OF PENDLETON'S GROUNDED SITUATION

SALVAGE OPERATIONS

Initial Reaction

In response to the initial request for salvage assistance, Commander, Task Force (CTF) 73, immediately deployed the USS BEAUFORT (ATS-2) from Subic Bay, Republic of the Philippines. At the same time the USS RECLAIMER (ARS-42), providing submarine support services at Hong Kong, and the USS HITCHITI (ATF-103), acting as an Oceanographic Survey Platform in the San Bernardino Straits, were placed on a rapid response standby. Additionally, the Naval Ship Repair Facility, Subic Bay, made ocean tow preparations on two barges and a self-propelled fuel barge (YOG). The Emergency Ship Salvage Material (ESSM) Base at Subic Bay also was alerted. Salvage equipment, including forklifts and cargo handling equipment, was prepared for loading onto the barges. On the day of the grounding, photo aircraft from VFP-63 aboard the USS HANCOCK (CVA-19) flew a mission over the PENDLETON and provided a number of high quality photos. Fleet Weather Control, Guam, was requested to provide 24- and 48-hour wind, sea, and surf forecasts to the salvage force twice daily.



Photographic reconnaissance aircraft from HANCOCK quickly provided useful graphic information on the PENDLETON's condition and situation.

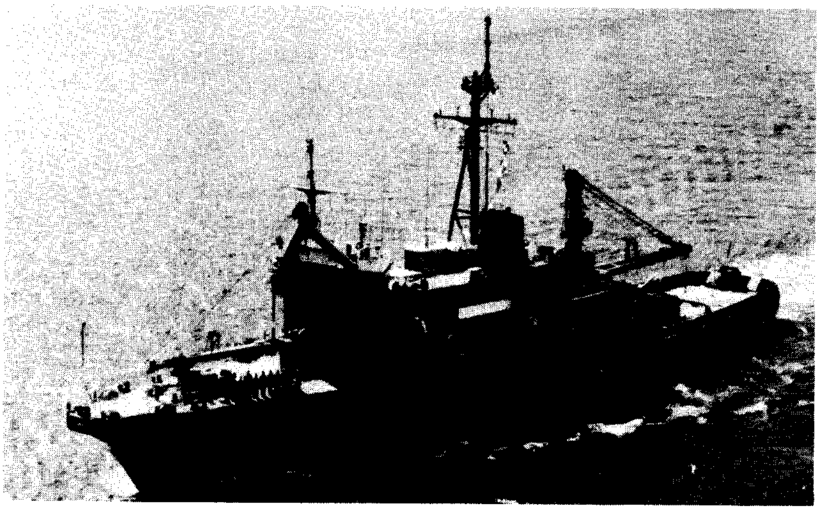
AIRCRAFT FROM USS HANCOCK (CVA-19) PROVIDED AERIAL PHOTOS

Initial Salvage Efforts

The BEAUFORT arrived on-scene on 27 September and immediately commenced preparations for a retraction attempt. Internal and external hull surveys were performed. The major portion of the 1,523 tons of seawater was pumped overboard and the 9,000 barrels of fuel oil was consolidated in the after tanks. BEAUFORT, in the meantime, was laying two legs of beach gear.

At high tide on 27 September, BEAUFORT made an unsuccessful attempt to retract the stranded vessel, generating 75 tons of pull from beach gear and an additional 40 tons from the force of PENDLETON's propeller. This force failed to produce any movement of the PENDLETON.

Several factors hampered the initial attempt. A three-knot current ran in a northerly direction parallel to the fringe of the reef, perpendicular to the tow line axis. This made it difficult for salvage ship station keeping. Moreover, the extreme beach gradient created poor beach gear pulling angles. At a distance of 700 yards from the PENDLETON's stern, the



First on-scene to assist PENDLETON, BEAUFORT quickly attempted to retract her after she had nearly deballasted and had consolidated 9,000 barrels of fuel aft. The attempt was not successful.

USS BEAUFORT (ATS-2) ARRIVED FIRST TO ASSIST

PENDLETON's condition at time of first unsuccessful retraction attempt by USS BEAUFORT (ATS-2). All saltwater ballast (1,523 tons) had been pumped overboard, and all 9,180 barrels of NSFO fuel oil (1,260 tons) had been consolidated in the after tanks.

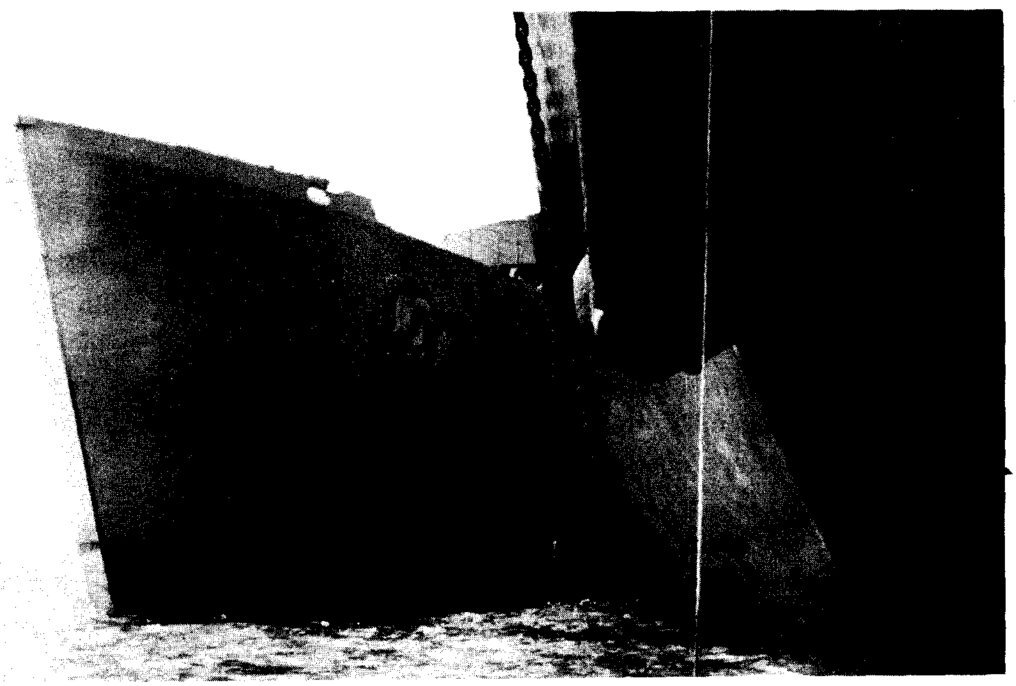
PENDLETON'S INITIAL SITUATION

water depth was over 100 fathoms. Finally, maximum high tides occurred during periods of darkness, making tow line hookup and salvage ship maneuvering difficult.

On 28 September, the RECLAIMER arrived on-scene and together with BEAUFORT attempted to retract the stranded vessel. This attempt also was unsuccessful.

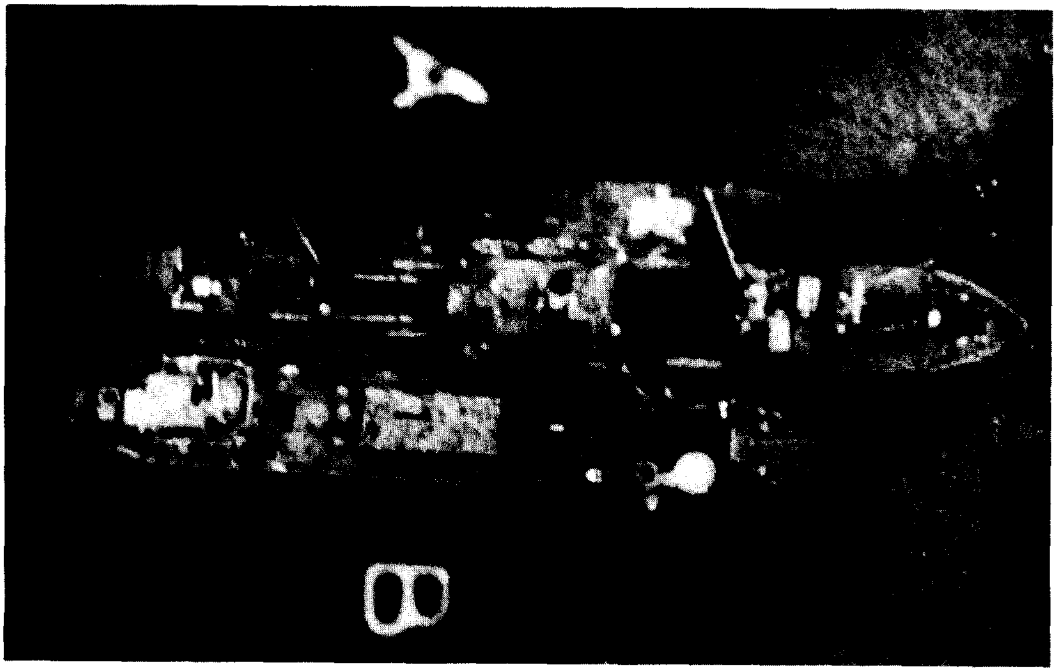
Further Preparations

Two sets of beach gear purchase were then transferred to the PENDLETON's fantail. On the 29th, BEAUFORT laid a leg of beach gear in 1,600 feet of water off the stranded vessel's port quarter and placed a strain on the leg from the PENDLETON's fantail. On the 30th, RECLAIMER also dropped a leg of beach gear off the PENDLETON's stern, but the crown buoy did not watch and the leg was lost. Both of the PENDLETON's bow anchors were kedged aft, over the fringe of the reef, and a strain was taken with the bow anchor windlass. Salvage personnel also began preparing hatches and booms for the major offload of ammunition from hold 3, which would commence upon the arrival of lighterage craft.



The USNS TIOGA COUNTY (T-LST-1158) arrived at Triton Island six days after grounding to receive cargo from PENDLETON.

TIOGA COUNTY ARRIVES TO ASSIST



Aerial reconnaissance photograph of unloading operations.

TIOGA COUNTY ALONGSIDE PENDLETON

Initial Offloading Efforts

It was estimated that, in order for the PENDLETON to be retracted, 1,400 tons of cargo would have to be offloaded from cargo holds 2 and 3. Offloading of 105mm ammunition from hold 3 presented no major problems. However, hold 2 was a different story. Here two 50-ton generators were deck-loaded. These generators were too heavy for any available equipment to move. PENDLETON's 50-ton jumbo boom, at the forward edge of hold 3, could not be topped-out over the hatch to hold 2.

On 1 October, the USNS TIOGA COUNTY (T-LST-1158) arrived at Triton Island and beached on the PENDLETON's starboard side at low tide. In her initial position, however, the forward and after booms at PENDLETON's hold 3 were unable to reach unobstructed deck area on the LST. The TIOGA COUNTY then deballasted forward, and moved further onto the reef with the rising tide. Offloading was then begun, using the yard and stay method. Inexperienced personnel limited efforts to only 7 tons per hour with forklifts. At 0900 on the morning of the 2nd, the HITCHITI arrived from Subic Bay with two barges, salvage equipment, and five additional electric forklifts with extra batteries.

Forklift Delays

The greatest single problem in offloading palletized ammunition was created by the electric forklifts. PENDLETON, down by the stern, had a deck gradient that overloaded the forklifts with the one-ton ammo pallets. Batteries were rapidly exhausted. Forklift control switches overheated, arced, and shorted out. The forklift batteries weigh 300 pounds each and had to be handled by the cargo boom, periodically interrupting pallet offloading. Recharging the batteries was slow, requiring at least six hours. Raised cloverleafs on the deck of the LST blocked the movements of the electric forklifts and required that the forklift drivers move between the rows of cloverleafs. The two rough terrain forklifts available, for which the cloverleafs were no problem, were unreliable. They frequently broke down or stalled. A lack of experienced forklift operators further hindered efforts.

Completion of Offloading Efforts

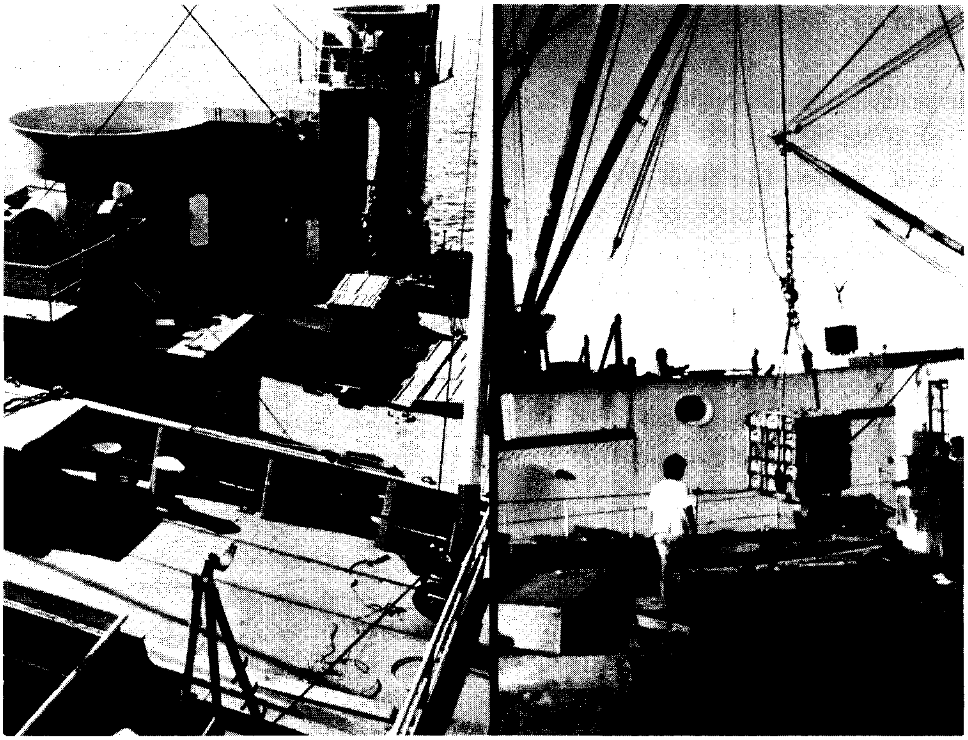
At noon on the 2nd, the Luzon Stevedoring Corporation (LUSTEVECO) tug VIKING arrived with an additional flat barge and 78 stevedores. On 28 September, Commander, Task Force 73 (CTF-73), had activated provisions of the NAVSEA Master Salvage Contract with LUSTEVECO.

With the arrival of the flat barges, additional equipment, and experienced stevedores, the offloading rate increased appreciably (except on the evening of 2 October when light rains made the square of the hatch in hold 3 very slippery. Sand had to be spread to improve forklift traction). By the morning of 3 October a total of 500 tons of ammunition had been offloaded, leaving a balance of 991 tons yet to be removed prior to the next retraction attempt.

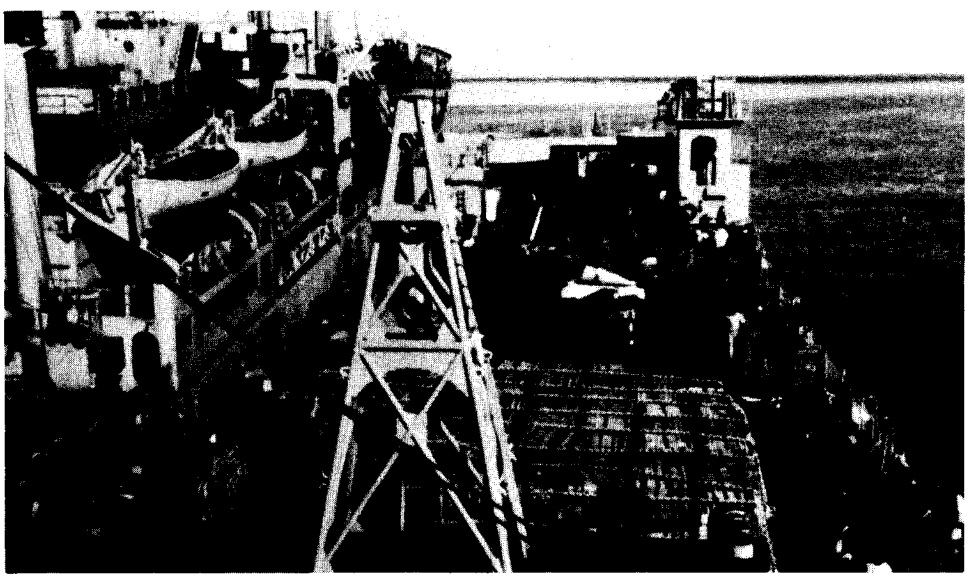
Threat of Typhoons Develops

At noon on 3 October, CTG 73.4 warned the Salvage Master of the approach of Typhoon NORA, and a plan had to be developed to abandon the PENDLETON on the 6th. The Salvage Master accordingly modified his plans to allow for a retraction attempt at the next high tide, 0100 on the 4th.

To complicate matters even further, another tropical storm – which developed into Typhoon OPAL – arose only 240 miles southeast of Triton Island. Signs of OPAL were evident at the island, as the weather began to deteriorate, winds picked up and the seas became choppy.



TIOGA COUNTY moved, alongside, forward enough so that cargo from hold 3 could be unloaded using PENDLETON's cargo booms. Forklifts were used to move pallets aft on deck of the TIOGA COUNTY.



AMMO CARGO FROM PENDLETON'S #3 HOLD BEING UNLOADED

Final Retraction Attempts

By early evening on the 3rd, preparations for the retraction attempt were being completed. The barge to port had been fully loaded with 208 tons of ammunition and was removed by the tug OSCEOLA. All forklifts were out of commission and offloading of ammunition to the LST continued by hand. By midnight, when all offloading operations had to be suspended, more than 600 tons of ammunition had been transferred.

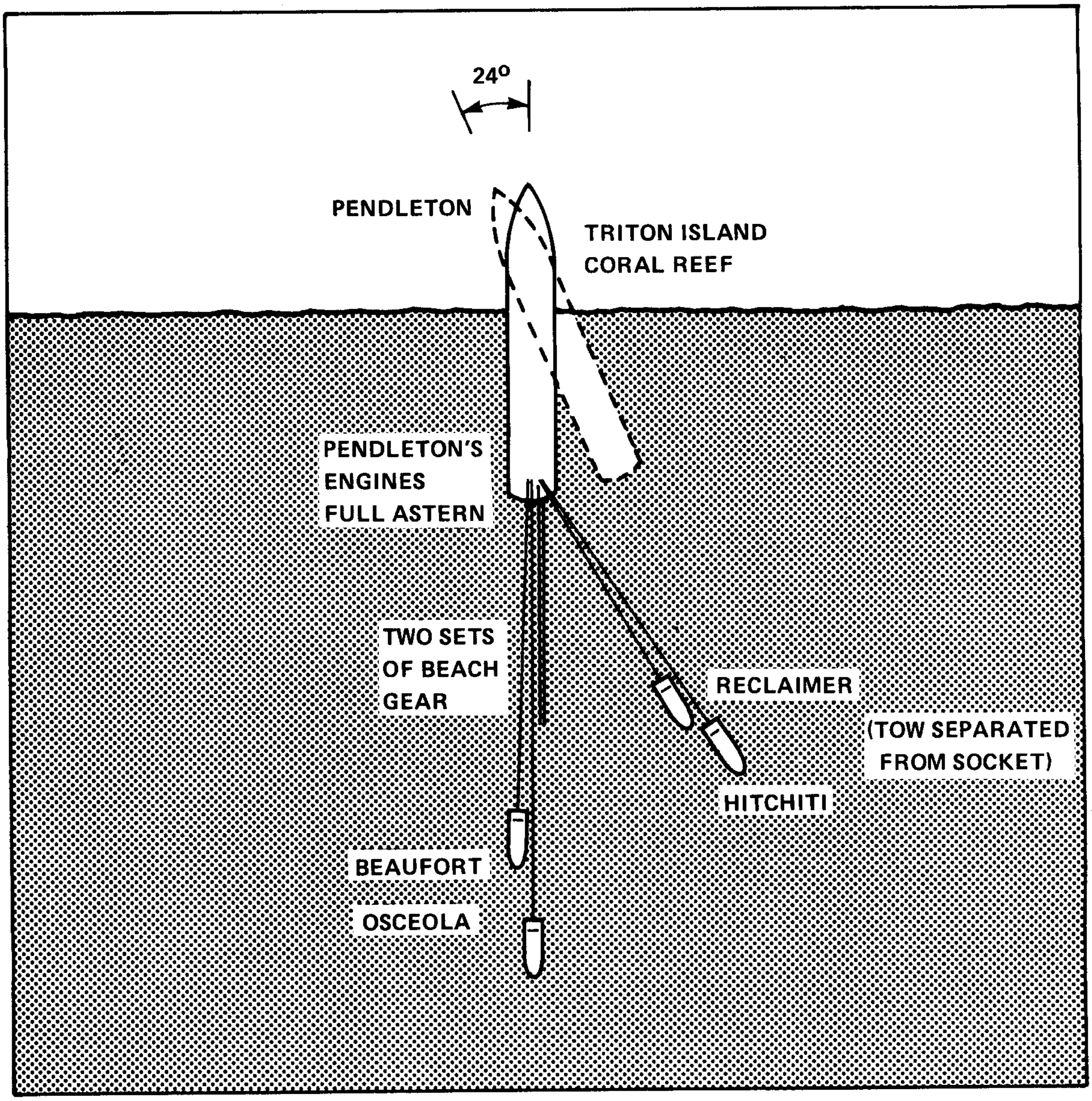
The retraction attempt was then begun almost immediately. By 0137 on 4 October, a maximum retraction pull of 165 tons was developed by the BEAUFORT and RECLAIMER. HITCHITI, however, was unable to get into harness on RECLAIMER's bow. The tug OSCEOLA attempted to hold BEAUFORT's bow into the strong northerly current. Meanwhile, the tug VIKING towed the barges to sea. TIOGA COUNTY remained alongside the PENDLETON to provide wrenching and bumping action with her engines and rudders. In the process, the PENDLETON's stern was shifted 15 degrees to port, but the retraction effort was unsuccessful.

The development of tropical storm OPAL into a typhoon further reduced the time available to the salvage force by a full day. The final retraction attempt was now scheduled for 0200 on 5 October.

Preparation for the final retraction attempt was begun immediately. The LUSTEVECO barge was moored alongside the PENDLETON to port to receive ammunition. RECLAIMER laid one leg of beach gear off the PENDLETON's starboard quarter and secured the wire to the beach gear purchase previously set up on the PENDLETON's fantail. All of PENDLETON's anchor chain was walked out onto the reef, feedwater was reduced to 20 tons, all fresh water was pumped overboard, and fuel service tanks were consolidated aft – all in an attempt to reduce grounding pressure. The Salvage Master investigated the feasibility of jettisoning the two 50-ton generators on the hatch of hold 2, but it was concluded that if dropped, once over the side they would either puncture or wedge the hull, preventing the retraction attempt in the remaining available time.

The attempt was begun at 0212 on the morning of 5 October. By that time a total of 2,950 tons of material had been removed, including 1,000 tons of ammunition. Based on a friction factor of .5 ton for a coral bottom, a calculated pull of 93 tons was required to retract the ship.

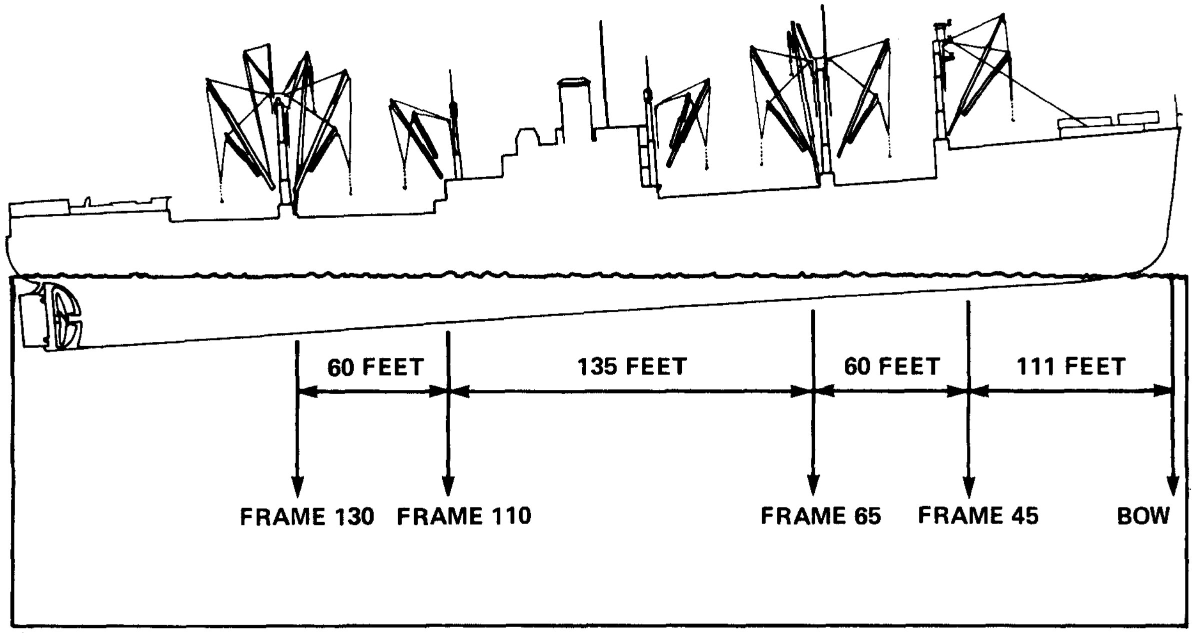
For the final attempt, RECLAIMER and HITCHITI were pulling in tandem on the PENDLETON's starboard quarter. BEAUFORT and OSCEOLA, together with the two sets



Pendleton was swinging easily through 24° about a point 95 feet abaft the bow. It was concluded that the structurally solid bulkhead at this point was restricted by a high spot in the reef, retarding any retraction.

PULL SCHEME FOR FINAL ATTEMPT TO RETRACT PENDLETON

of beach gear on the PENDLETON's fantail, pulled directly astern. The PENDLETON's engines were at full astern. The RECLAIMER's tow line separated from its socket, eliminating her from the retraction attempt. The overall result was to swing PENDLETON



LOADING FOR FIRST RETRACTION ATTEMPT, 27 SEPTEMBER

	No. 5 Hold	No. 4 Hold	No. 3 Hold	No. 2 Hold	
Deck Cargo				100 Tons	
Tween Deck		108 Tons	331 Tons	57 Tons	
Hold	213 Tons	464 Tons	768 Tons	231 Tons	
Tanks	1359 Tons	235 Tons			
Total	1572 Tons	807 Tons	1099 Tons	388 Tons	Total: 3866 Tons
	40.7%	20.9%	28.4%	10.0%	

LOADING FOR FINAL RETRACTION ATTEMPT, 4 OCTOBER

	No. 5 Hold	No. 4 Hold	No. 3 Hold	No. 2 Hold	
Deck Cargo				100 Tons	
Tween Deck		108 Tons		57 Tons	
Hold	213 Tons	464 Tons	99 Tons	231 Tons	
Tanks	1572 Tons	20 Tons			
Total	1785 Tons	592 Tons	99 Tons	388 Tons	Total: 2864 Tons
	59.3%	22.3%	3.7%	14.7%	

LOADING SITUATION FOR PENDLETON RETRACTION ATTEMPTS

USS RECLAIMER (ARS-42) was paired with USS HITCHITI (ATF-102) on PENDLETON's starboard quarter. USS BEAUFORT (ATS-2) see page 50 and OSCEOLA (YTM-129) (not shown) pulled directly astern.

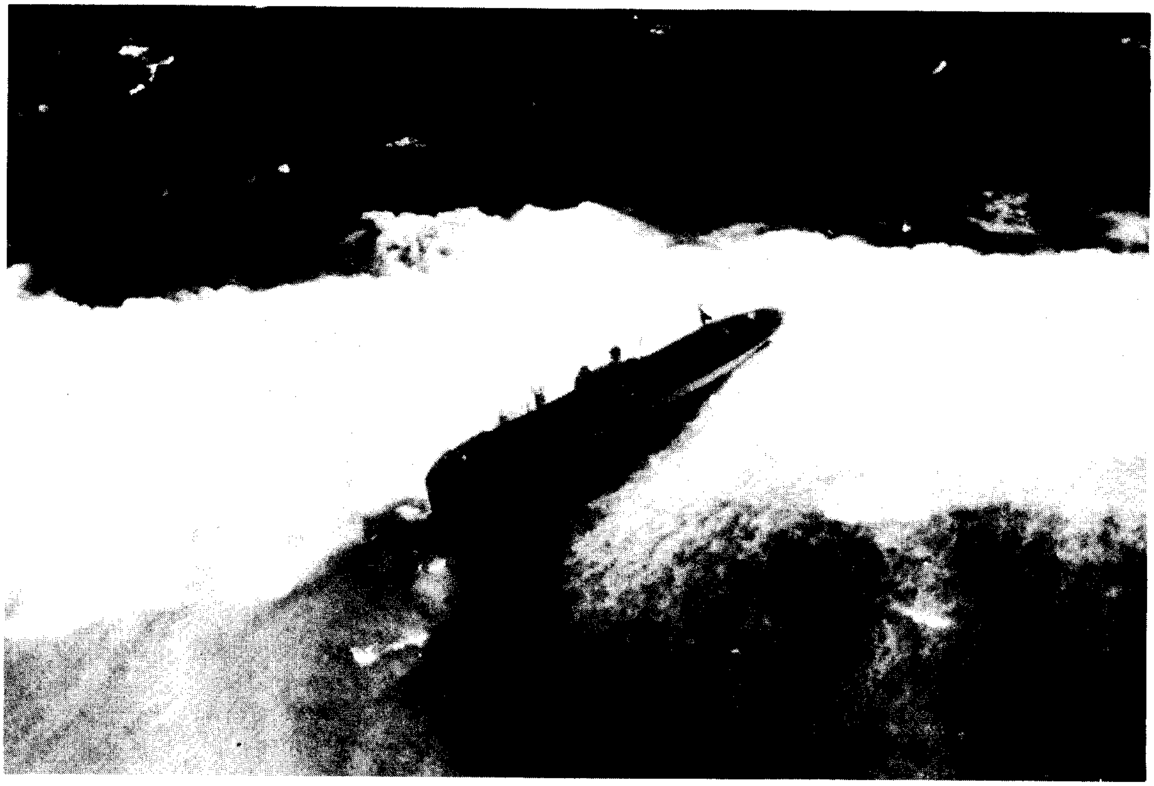
SALVAGE SHIPS PARTICIPATING IN THE RETRACTION EFFORT

easily through 24°, on a pivot point 95 feet abaft of the bow (just aft of the transverse watertight bulkhead between cargo holds 1 and 2); and despite all efforts, this attempt too, was unsuccessful. It was later concluded that the structurally solid transverse bulkhead, located at the pivot point, retarded the PENDLETON's retraction by hanging up on a reef high point.

Upon completion of this attempt, some ammunition offloading was undertaken as well as preparations for storm conditions. Preparations included ballasting the PENDLETON, securing hatch covers, making anchor chains taut, and stoppering. At 0624 on the 5th, Commander, SEVENTH Fleet, directed the salvage forces to evacuate the PENDLETON for evasion of Typhoons NORA and OPAL. Helicopters evacuated 140 salvage personnel to the USS CAMDEN (AOE-2) and BEAUFORT.

Typhoons OPAL, NORA and PATSY

During the period from 7 to 8 October, NORA and OPAL passed through the area. On the 9th, CAMDEN returned to Triton Island. An aerial inspection of the PENDLETON by



PENDLETON BROACHING ONTO REEF DURING TYPHOON RUTH

key salvage personnel found her broached-to, port side inboard of the reef, still intact but severely damaged. On the 10th, a small survey party boarded the ship to make a salvage assessment. The PENDLETON was hard aground on the fringe of the reef, with surf continuously pounding into the starboard side. One set of beach gear from her fantail had parted, the other was under heavy strain, and the port bow anchor had parted.

The ship itself had suffered extensive destruction. The port side was severely damaged along the turn of the bilge, with numerous double bottom tanks open to the sea. Cargo holds 2 and 3 were filled with oil and water, in free communication with the sea. The ship was buckled amidships, her superstructure evidenced gross distortion, and a lifeboat had been carried away.

Stripping Ship Plans

On 11 October, Commander, Military Sealift Command (MSC), declared the PENDLETON a loss. It was decided to strip the ship of high value equipage and crew's belongings, and to completely offload the remaining ammunition, using helicopters. A list of highly valuable strip ship items was obtained from the PENDLETON's master. The unused fuel oil, 8,000 barrels, would be removed to "sanitize" the PENDLETON against ecological pollution.

To supplement the salvage force, providing additional support for the offloading operations, the USS DULUTH (LPD-6) was sent to Triton Island. Assets available from the DULUTH added two CH-53 helicopters, two CH-46 helicopters, four LCM-8's, and additional forklifts, batteries, generators, and tools to the salvage efforts.

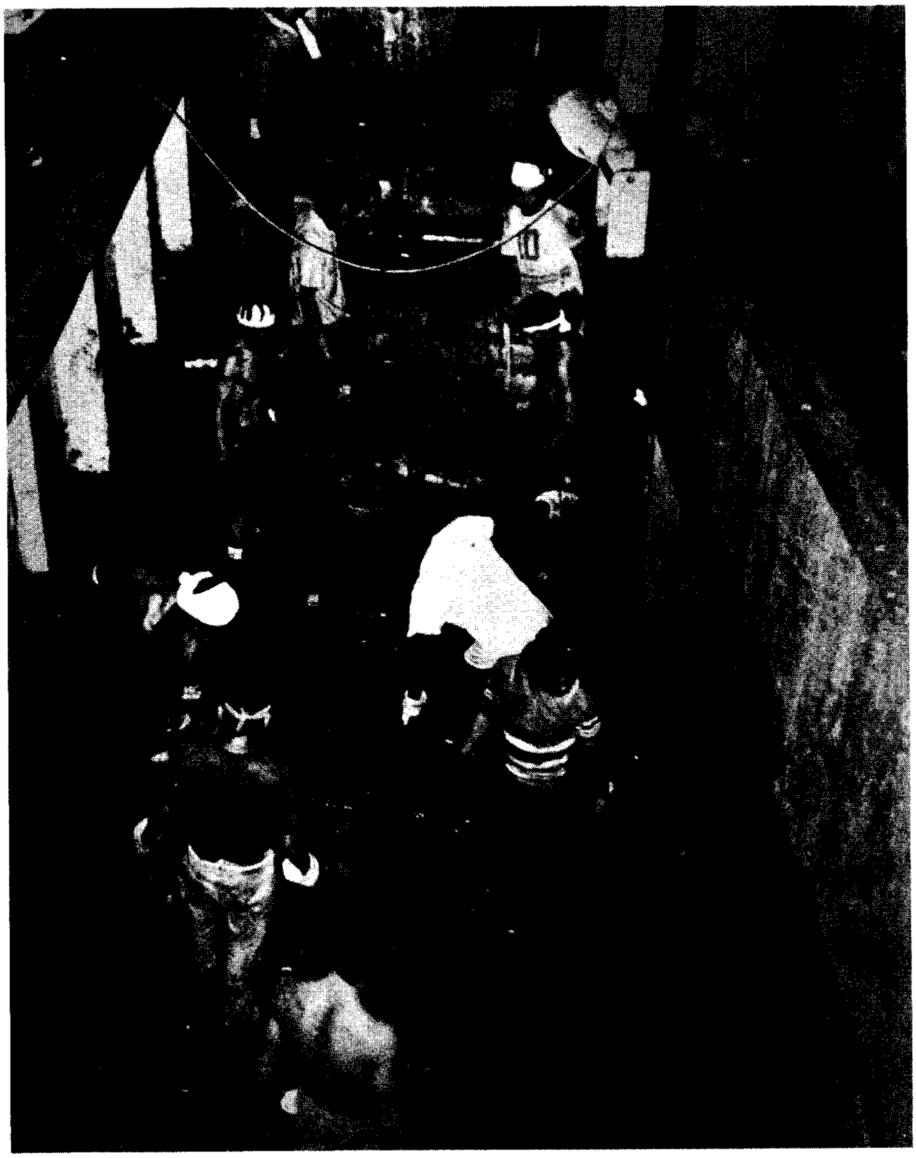
At noon on 13 October, the salvage force again had to depart Triton Island, this time to avoid Typhoon PATSY; on the 15th they returned to find the condition of the wreck unchanged. Although high seas prevented the use of LCM-8 landing craft for offloading cargo, LUSTEVECO stevedores and U.S. Naval personnel, then succeeded in removing 45 tons of high value material in 102 lifts by CH-53 helicopters.

Typhoon RUTH

On 16 October, still another typhoon, RUTH, began approaching the island. Offloading operations were again terminated and DULUTH sailed south for typhoon evasion the same day. The salvage force returned to Triton Island on the morning of the 19th to find the PENDLETON's condition vastly altered. The force of Typhoon RUTH had pushed the PENDLETON 70 yards onto the reef, the ship's rudder had been broken off, remaining beach gear wire had parted, and the ship was leaking fuel oil.

FINAL OFFLOADING

Since most of the cargo to be offloaded was ammunition, the ammunition ship USS MOUNT HOOD (AE-29) was assigned to the salvage force. The helicopter's vertical-replenishment capability was expected to enhance the efficiency and ammunition-handling safety with which the operations were conducted. During the evasion of Typhoon RUTH, the DULUTH was detached for other duty and salvage force personnel aboard were transferred to the USS MOUNT VERNON (LSD-39). The salvage force, with the exception of the MOUNT HOOD, then returned to Triton Island on the morning of 19 October.



LUSTEVECO stevedores are shown removing oil soaked pallets from the hold. The four successive typhoons had severely complicated the task of offloading. Ammunition pallets remaining in cargo holds were oil and water soaked, pallets broken, and contents scattered. High danger of fire existed aboard the wreck. Wiring on board was badly deteriorated and use of electric power would have been dangerous. Oil soaked dunnage and accumulation of other flammable debris enhanced this danger. With the ship's pump and main fire system inoperable, emergency fire fighting equipment had to be brought aboard.

DAMAGE ABOARD PENDLETON AFTER TYPHOONS

Cumulative Effects of Four Typhoons

Four successive typhoons had severely complicated the task of offloading cargo. Ammunition pallets remaining in cargo holds 2 and 3 were oil and water soaked, with most pallets broken and contents scattered. All ship's machinery was out of commission, and wiring for winches and pumps was badly deteriorated. To run the necessary pieces of unloading equipment, portable power sources were required, but with the ship high aground, no vessels could come alongside. A special channel would have had to be blasted in the reef to allow a floating crane to come alongside to offload the 50-ton generators. All offloading of ammunition, therefore, continued to be accomplished by helicopter.

Fire Hazard

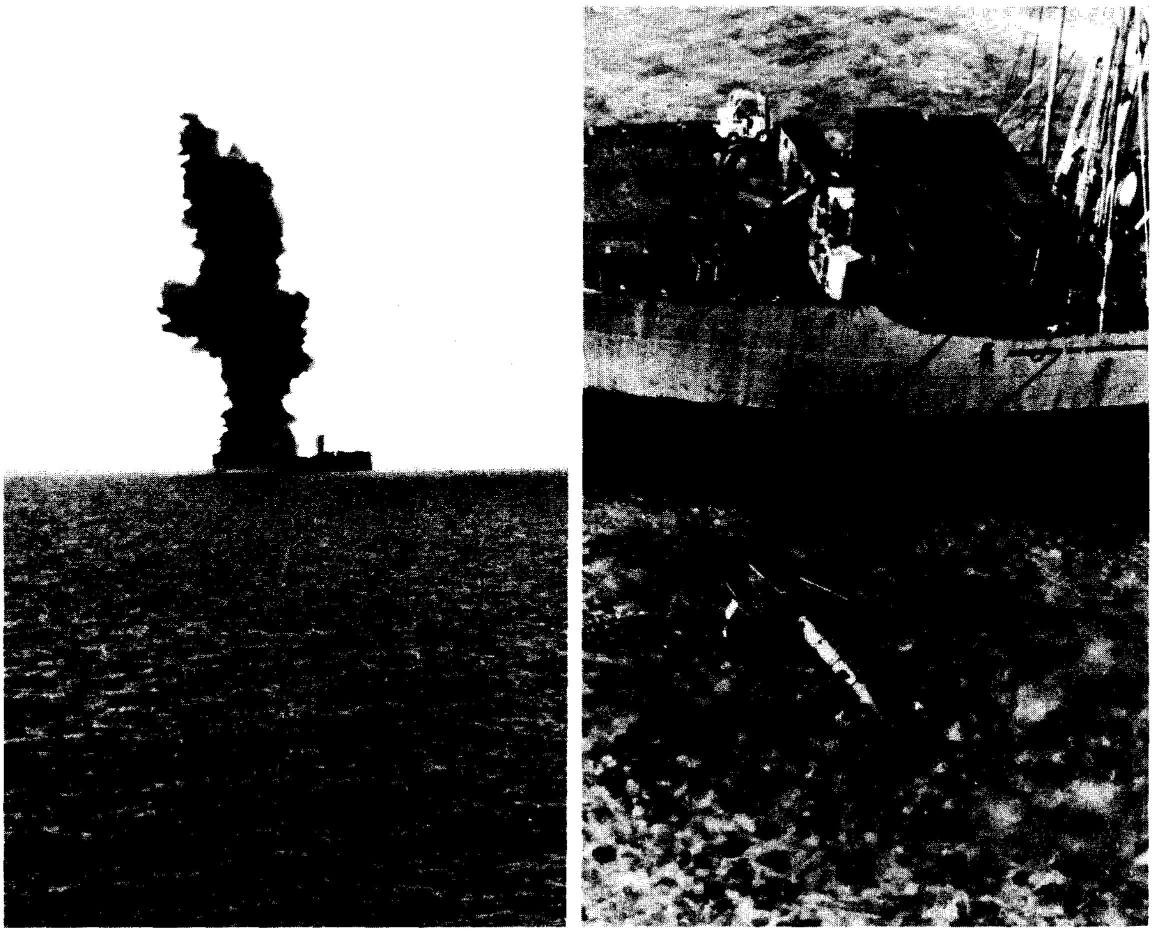
High danger of fire also existed aboard the wreck. Wiring on board was badly deteriorated and switchboards had been continually doused with salt water during the typhoons. Even with supplied power the use of ship's circuitry would have been hazardous. The oil soaked dunnage and accumulation of other flammable debris also increased the danger of fire. Inasmuch as the ship's pump and firemain system were inoperable, emergency fire fighting stations had to be established throughout the ship.

Preparations for Offloading

From 19 to 22 October, preparations continued to offload ammunition. The salvage party cleared dunnage from the holds and dewatered hold 5. An emergency firemain was established and the ship was cleared of combustible materials. AC generators and rectifiers were transferred to the PENDLETON to provide DC power to the winches. Underwater leaks in fuel tanks were plugged, and the ship's fuel oil service pumps were tested for use in POL transfer.

Removal of the Forward Mast

During this period, two helo offloading stations were established. This required the removal of several projecting structures for helo safety. The after station provided no problems and was easily cleared; however, the forward station required explosive removal of the forward mast. This mast was 6 feet in diameter and made from 1-inch-thick steel. To remove the mast, shipfitters first skip-cut around it on a diagonal, oriented downward to port, in the direction desired for the mast to fall. Ten haversacks of C-4 explosives were then used. Four haversacks were placed to port, at deck level, below the skip-cut. Four haversacks were also placed to starboard, just below the crosstree to starboard, to be used as "kickers" to push the mast to port. The ship was then evacuated, and using a fifteen minute delay fuse, the detonation took place as planned. Removal was entirely successful. The mast was pushed 40 feet to port, clearing the side, causing no fires and only minimal damage.



Shipfitters made a preliminary skip-cut on the mast, oriented diagonally downward to port. Four haversacks of C-4 explosives were placed on the mast's port side below the cut. Four haversacks were placed to starboard above the cut, and two more were placed to starboard above the crosstree, to act as "kickers." Detonation pushed the mast neatly to port, clearing the side, with minimal damage.

FOR HELICOPTER OFFLOADING, PENDLETON'S FOREMAST HAD TO BE REMOVED

Offloading Operations

The MOUNT HOOD arrived at Triton Island on 22 October and offloading began immediately. Removal of 350 tons of oil-soaked ammunition from cargo holds 2 and 3 was accomplished by handling ammunition boxes individually. Ammunition in holds 4 and 5 was undamaged, and could be offloaded by the pallet. Shipfitters cut large holes in the transverse bulkheads separating holds 2 and 3, and 4 and 5, to permit the transfer of ammunition to holds 3 and 5, which were not blocked by the deck-loaded generators. Cargo from holds 2 and 3 was moved to the forward helo station, and cargo from holds 4 and 5 moved aft to the after station.

Helicopter Lift

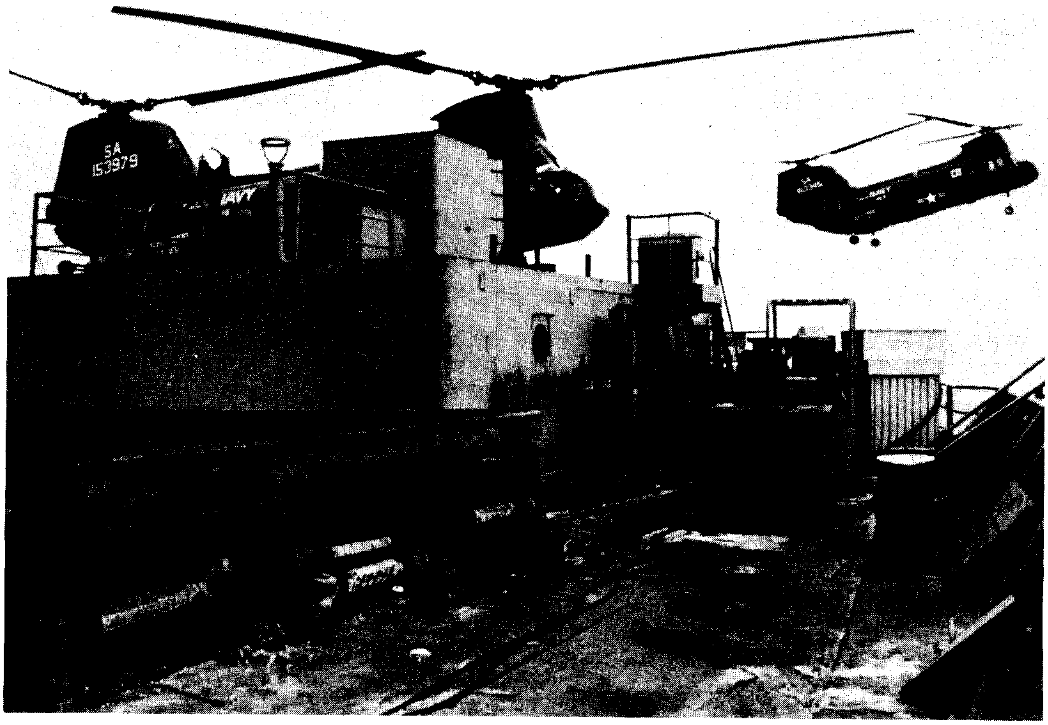
Two CH-46 helicopters from the MOUNT HOOD transferred the cargo from the helo stations to the ammunition ship. Although a CH-46 has a lift capability of 6,000 pounds, the oil/water-soaked ammunition had become significantly heavier and lifts were limited to 40 boxes, whose dry weight was normally only 4,360 pounds. The two helos offloaded cargo at a rate of 30 tons per hour, a rate far in excess of the yard and stay method of transfer previously used. The availability of two more U.S. Marine Corps helicopter support teams for spotting pallets, controlling cargo net hookups and further expediting ammunition offloading, contributed significantly to this increased cargo offload rate. All transfer of personnel and equipment was also accomplished by helicopter.

Operations were briefly interrupted on 23 October when it was determined that the oil-soaked ammunition presented an acute spontaneous-combustion hazard. Consideration given to dumping this ammunition in deep water was rejected because of Navy policy avoiding the dumping of ammunition in the oceans. The contaminated ammunition was then transferred to open deck stowage aboard the USS TRAVERSE COUNTY (LST-1160).

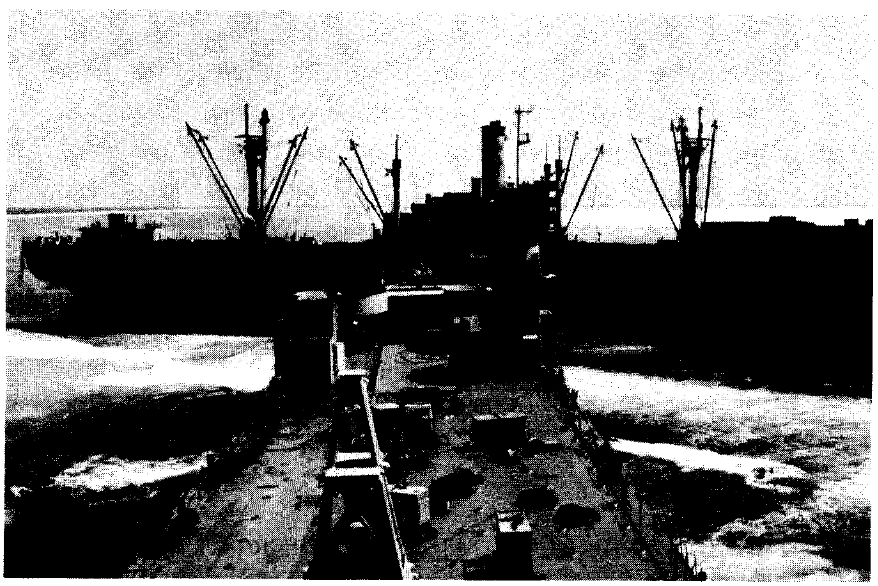
Offloading operations continued until 1800 on 28 October, when all ammunition had been removed from the wreck.

Coral Channeling

During offloading, preparations were going on by members of the UDT team aboard the MOUNT VERNON to blast a channel through the coral to put a floating crane alongside the PENDLETON to remove the 50-ton generators. A number of blasts were detonated,



Helicopters were used to remove dry cargo and valuable gear. TIOGA COUNTY beached as close to PENDLETON as possible, and pumped her dry of over 1,600 barrels of fuel, using six inch salvage hose through her bow doors and suspended from a manila high line.



APPROACHING PENDLETON FOR FINAL OFFLOADING

clearing a small channel. It was determined that two double shots were required in each case: one to pulverize the coral and another to clear it from the channel. Bundles of MK-8 hose charge were used. These bundles were assembled on Triton Island and then transferred to the detonation site by helo. On 26 October, a blast severely damaged fuel tanks on the PENDLETON, resulting in a fuel oil spill of 6,400 barrels. Fortunately, the oil dissipated itself at sea without pollution of the reefs or beaches at Triton Island, but blasting was suspended until all fuel oil and ammunition had been removed.

Oil Removal

Because of the limited electrical power available, removal of remaining fuel oil was conducted after the completion of ammunition offloading. On 29 October, a small salvage party boarded the PENDLETON to prepare for fuel removal. Test pumping of the ship's fuel tanks showed that all fuel oil transfer piping was intact. The ship's reciprocating ship service fuel oil transfer pumps were then tested using low pressure air, and found to be capable of pumping fuel at a good rate. Two salvage air compressors were transferred to the PENDLETON by work boat, from the RECLAIMER, to run these pumps.

By 1 November, surf conditions moderated substantially and the TIOGA COUNTY beached on the fringe of the reef, 80 yards from the PENDLETON. Anti-broaching lines were run to both the port and starboard sides of the LST from the PENDLETON. Using a manila highline, 25 lengths of lightweight 6-inch salvage hose were then run from the PENDLETON, through the LST's bow doors and into her ballast tanks. Pumping was begun at 1500 at a rate of two barrels per minute.

Pumping continued into the night. Although the 6-inch salvage hose was severely buffeted against the coral bottom by surf, it suffered no damage and no leakage occurred. By 0230 on the morning of the 2nd, over 1,600 barrels had been transferred and the PENDLETON was dry. Thus loaded, the TIOGA COUNTY experienced great difficulty retracting from the reef and it was not until 1400 that she was free of the reef.

TERMINATION OF OPERATIONS

The PENDLETON was now clear of all cargo and oil except for the four 50-ton generators and associated switching gear. The RECLAIMER and HITCHITI remained in the area to conduct channel blasting in preparation for a floating crane to remove this final cargo. Weather conditions, however, limited the work that could be accomplished, and it soon became apparent that bad weather had set in for the season. Crane services were then canceled, the remaining explosives detonated on the reef, and, by 6 November, all salvage efforts were terminated.

CONCLUSIONS

Severe distance and weather handicaps prevented the full employment of adequate salvage resources in time to permit the successful retraction of the PENDLETON. The untimely descent of Typhoons NORA, OPAL, PATSY and RUTH completely halted salvage operations, 10 days after PENDLETON's grounding, and converted a chance for possible recovery into a broached and broken hull, high on a shallow coral reef. Thereafter, salvage operations had to be confined to efficient stripping of cargo, ship fittings, other valuables and fuel, and the prevention of ocean pollution.

It is possible that the severe conditions of this particular grounding would have precluded successful retraction under the best of circumstances. PENDLETON was put aground at nearly maximum speed (17.5 knots), at monthly high water. Moreover, 100 tons of deck cargo, too heavy to unload, lay atop the hatch of hold 2, blocking 288 tons of cargo, all directly over the point of grounding. Nevertheless, it was disappointing to the salvage force to lose the contest to the typhoon season, before the salvage effort could fairly come to grips with the challenging problems that were posed.

Prompt aerial reconnaissance photography, conducted within half a day of the grounding, provided clear graphic supplement to message reports of the PENDLETON's situation. This resource was efficiently exploited to provide intelligence in coping with this natural rather than human adversary.

Four retraction efforts were made. On 27 September, USS BEAUFORT (ATS-2) made an attempt after PENDLETON deballasted 1,523 tons of salt water and consolidated 9,000 barrels of fuel in after stowage tanks. Next day, upon arrival of USS RECLAIMER (ARS-42), a joint effort was made. Upon arrival of cargo barges, stevedores and an LST for offloading, the effort was focused on offloading of ammunition from hold 3, together with deballasting a concentration of fuel in after tanks.

With 600 tons of cargo offloaded, early on 4 October, BEAUFORT and RECLAIMER made a maximum retraction pull (165 tons) that shifted PENDLETON's stern 15° to port, but again retraction was not achieved.

Weather began to deteriorate on 4 October and a final retraction effort was rushed for next day, by which time nearly 3,000 tons of ballast and other weights had been removed. BEAUFORT, RECLAIMER, HITCHITI, and OSCEOLA then sought a combined effort, but this too was unsuccessful. PENDLETON, again, merely pivoted about a point under a total of 388 tons of deck load and blocked hold cargo. The salvage force, as directed by Commander, SEVENTH Fleet, then had to evacuate PENDLETON for evasion of Typhoons OPAL, NORA, PATSY, and RUTH.

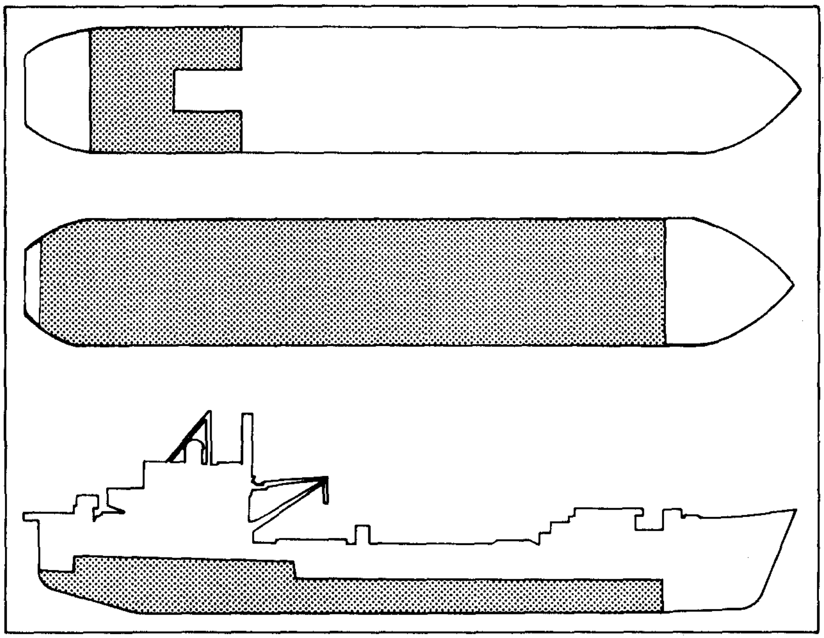
By the time salvage efforts could be resumed, ten days later, on 15 October, PENDLETON was broached 70 yards onto the reef, and had been declared a loss by Commander, MSC. Extensive damage included holing, buckling and gross topside destruction.

Ultimately, most of the high value strip-ship items and residual cargo ammunition were removed using the vertical replenishment helicopters of the USS MOUNT HOOD (AE-29) and two USMC helicopter support teams. Fuel transfer was delayed until high surf subsided, permitting an LST to beach close enough to PENDLETON to run 6-inch salvage hose by high line, and on 1 and 2 November, 1,600 barrels of oil were removed.

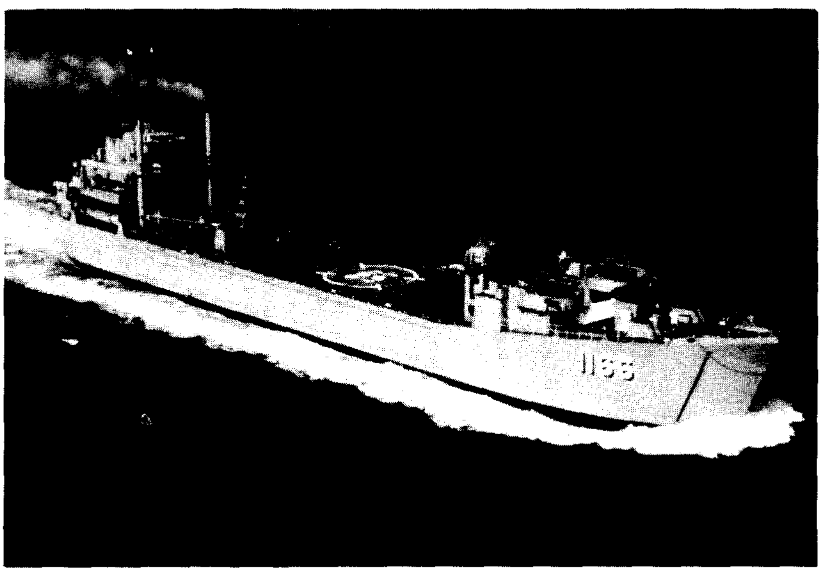
FOAM "SINK-PROOFING" OF LST

FOR TEST OF

HAIPHONG MINESWEEPING



Polyurethane foam, in a liquid state, was pumped into selected spaces of the WASHTENAW COUNTY.



The USS WASHTENAW COUNTY (LST-1166) was made sink-proof under the direction of SUPSALV at the U.S. Naval Ship Repair Facility, Yokosuka, Japan. Subsequently the LST was maneuvered extensively throughout the Haiphong Channel, North Vietnam, to demonstrate the elimination of previously laid U.S. mines.

LST MADE SINK-PROOF WITH POLYURETHANE FOAM INSTALLATION FOR MINESWEEPING TEST

FOAM "SINK-PROOFING" OF LST FOR TEST OF HAIPHONG MINESWEEPING

INTRODUCTION

In early 1973, Commander, U.S. Naval Ship Systems Command, tasked the Supervisor of Salvage (SUPSALV) to fill buoyant spaces of an LST with polyurethane foam. A substantially unsinkable "guinea pig" was needed for use in Project ENDSWEEP, an operation to demonstrate that the Haiphong Channel, in North Vietnam, was free of mines. The purpose in "sink-proofing" the LST was to enable it to be safely maneuvered throughout the channel, revealing any residual mines by detonation. The foam technique for positive buoyancy was selected not only to achieve permanent residual buoyancy, but also to attenuate shock in the event of an underwater explosion.

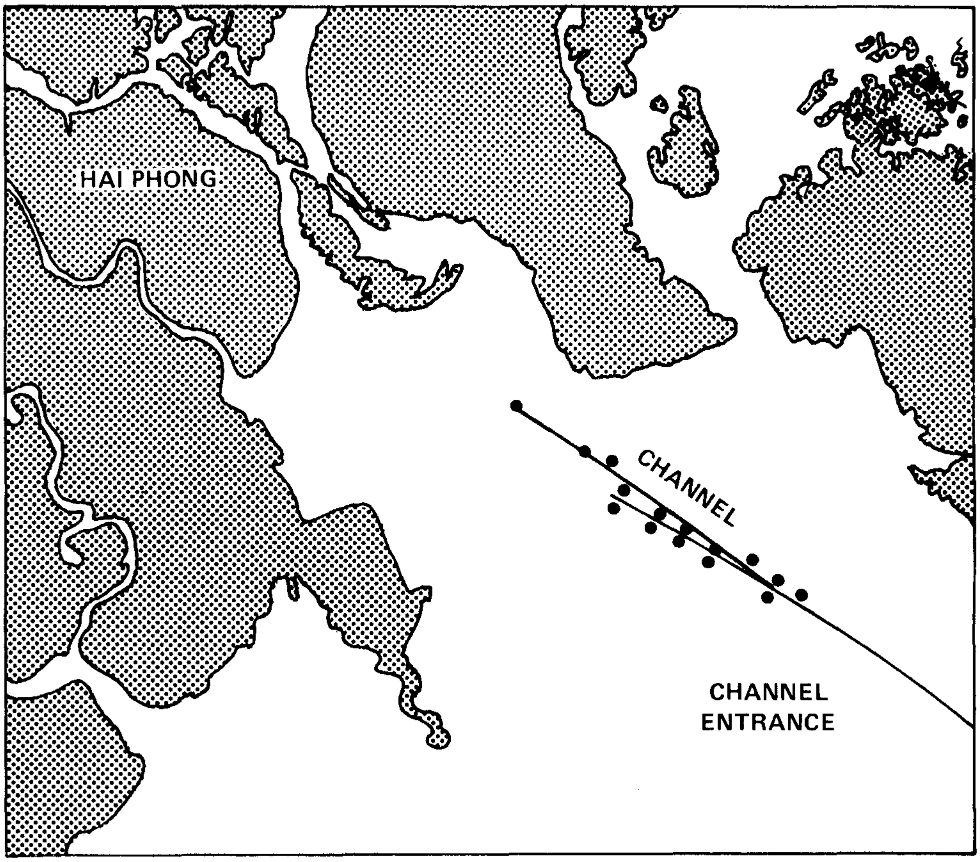
SUPSALV provided a Representative, on-site, to coordinate the installation of the foam at Yokosuka, Japan. The Murphy Pacific Marine Salvage Company, a pioneer in the application of foam to ship salvage, was engaged to provide the foam and implant it (with local labor) at the Naval Ship Repair Facility (SRF) in Yokosuka. Time was a critical factor, in view of the arrangements that had been negotiated with North Vietnam. Eleven days were allocated for the foam implantment.

The work was done in February 1973. The SUPSALV Representative, together with Murphy Pacific's foam experts, applied approximately 161,000 cubic feet of foam in the LST's compartments. Three independent foam dispensing heads were used, each with 275 feet of hose. Working around the clock, the implantment was completed in 5 days, well ahead of schedule. The LST was then deployed to Vietnam where it was maneuvered extensively in the Haiphong Channel, successfully demonstrating that the area was indeed free of danger of underwater explosives.

BACKGROUND

Urgent Politico-Military Situation

To recognize the urgency under which this project was executed, it is necessary to remember that mining of the Haiphong Channel was among the measures used to force the North Vietnamese Communists to negotiate a cease fire in 1972, and that the U.S. Navy was thereafter committed to removal of these minefields. Actually, the mines had already substantially eliminated themselves by timed sterilization. So, although the minesweeping conducted under Operation ENDSWEEP involved relatively little destructive detonation, and perhaps because of this, it was necessary to demonstrate that these mines no longer constituted a hazard. Accordingly, the U.S. Navy was obliged to demonstrate the safe passage of a test vessel without delay.



Among measures to force the North Vietnamese Communists to negotiate a cease fire in 1972, was the mining by U.S. naval aircraft of Haiphong Channel. The U.S., in turn, agreed in the negotiations to eliminate the mines.

HAIPHONG HARBOR AND CHANNEL

LST Suitability

For this purpose an LST is well suited, by virtue of its appropriate magnetic, acoustic, and bottom-pressure signatures. An LST also has sufficiently shallow draft to allow for the degree of settling that mine damage would involve, even after application of "sink-proofing" with foam. Still another advantage is engine control from the bridge, which permits operating without personnel in engineering spaces, closely exposed to any underwater blasts.

Salvage Foam for Sink-Proofing

The installation of polyurethane foam for sink-proofing constituted an imaginative reversal of the development of "foam-in-salvage" as it is called. Polyurethane foam has been used for many years to provide virtually undamageable buoyancy chambers for boats and canoes made of non-buoyant materials such as metal or fiber-glass-plastic. Its subsequent application to salvage necessitated development of a transportable system for foam application at salvage sites. Such use has been pioneered by the Murphy Pacific Marine Salvage Company (MYPAC) for both surface and underwater salvage situations. The foaming of spaces in an LST constituted a return to the unsinkable canoe concept on a giant scale.

Foam-in-salvage, essentially, uses plastic-foam-entrapped air to provide buoyancy where needed. The plastic foam, in liquid form, is conveniently pumped into flooded or floodable spaces that would be difficult or slow to make airtight. It hardens into a rigid mass in two minutes, providing buoyant air in the cells of the plastic that cannot leak, as well as some degree of structural strength, which may be needed. While it is not as buoyant as air alone, its density is as low as 2 lb/ft^3, and this provides at least 60 pounds of buoyancy per cubic foot.

Polyurethane foam is the product of a reaction between two chemicals: isocyanate resin and a polyol catalyst. These liquid chemical components are stored in separate containers from which they are propelled by compressed nitrogen. A third chemical, a liquified fluorocarbon (Freon) foaming agent, may be preblended in the separate chemical containers, or as was done in this case, blended with the two chemicals during the delivery process en route to the foam gun. Once the chemicals reach the foam gun, where they are mixed and released through the gun nozzle, the pressure reduction upon release changes the liquified Freon to gas, and the poly-isocyanate compound is rapidly foamed by it. It hardens in one to two minutes, quickly forming countless tiny cells with the Freon gas trapped inside. As the foam expands and hardens, it results in a rigid block of buoyant foam that can deplace an equal volume of water many times the foam's weight.

There are three types of foam delivery systems: aerosol, mechanical, and combination aerosol-mechanical. They are distinguished primarily by the pressure sources needed to propel the chemicals through their respective hoses to the delivery gun, dependent on depth and pressure. In the aerosol system, only the nitrogen is needed to propel the two chemicals. The low pressure system is used for shallow water applications, and was of course, quite adequate for the spaces of the LST.

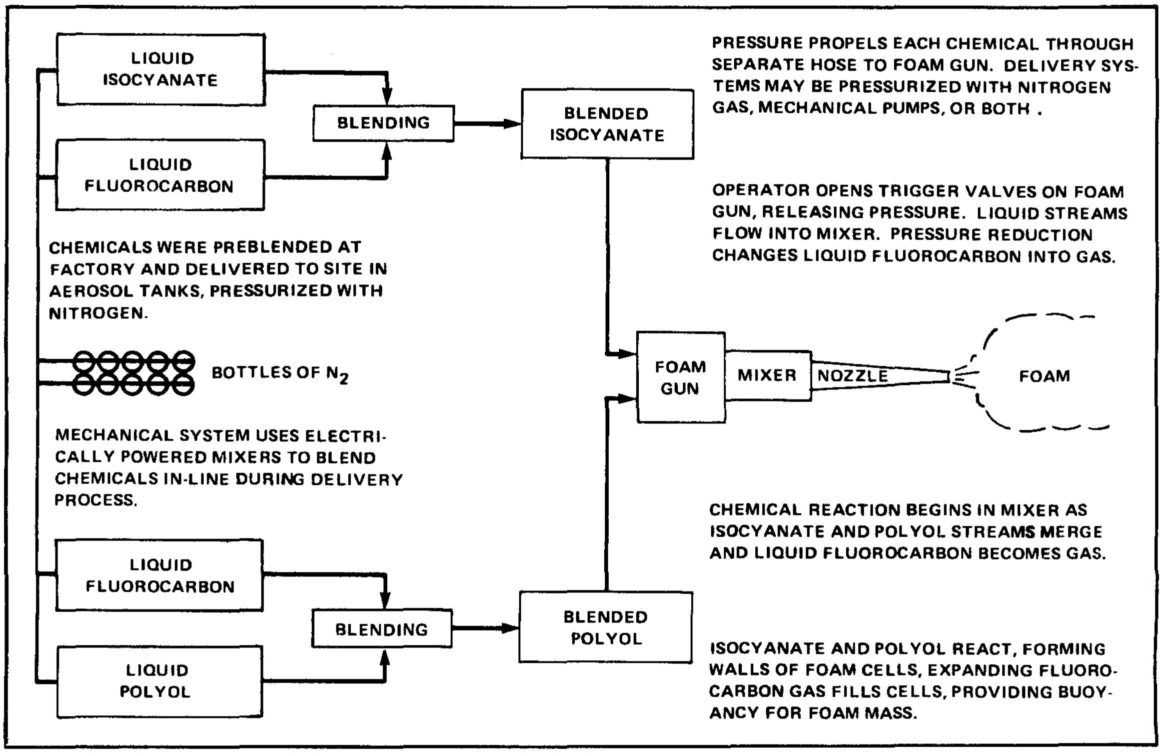
THE FOAM INSTALLATION PROJECT

LST Selection

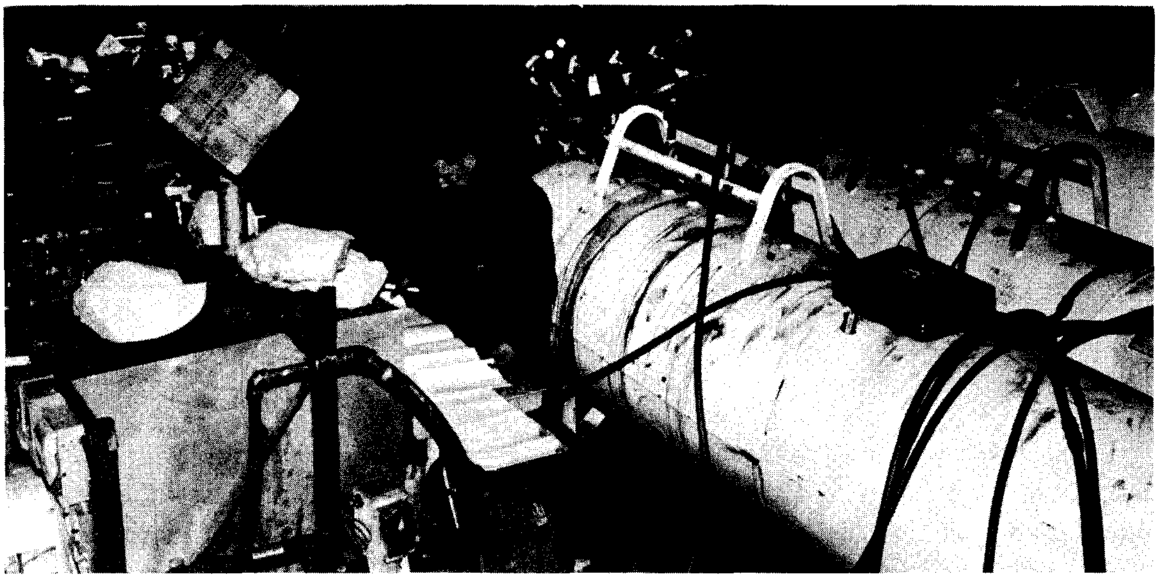
The USS WASHTENAW COUNTY (LST-1166), an LST of the 1156 Class, available at Yokosuka, Japan, was selected to have the foam installation that would convert it to an MSS (special minesweeper), or "Guinea Pig" as they are sometimes called. Beside the previously mentioned requisite mine-triggering signature, an LST of this class had additional characteristics of a variable pitch propeller and the capability of engine control from the bridge. The variable pitch propeller makes the 1156 Class LST highly maneuverable, a characteristic needed for handily negotiating the Haiphong Channel. The bridge engine-controls permitted evacuation of engine spaces to avoid the especially dangerous exposure of personnel in engineering spaces from underwater explosions. Moreover, the shallow draft, in general, of LSTs provided a margin for some settling in the water (despite foam sink-proofing) that would minimize danger of stranding in such circumstances. Also, with a draft of just under 5,800 tons, it could be taken under tow in emergency by a CH-53 helicopter.

Deployment of Salvage Resources

SUPSALV, when tasked with providing technical expertise and necessary equipment, was able to draw on experience with foam-in-salvage from the successful recovery of the USS FRANK KNOX in 1965 and the SS SIDNEY SMITH in 1972. The support of Murphy Pacific Marine Salvage Company was again called upon to handle the operation, providing equipment and technical supervisory personnel. The necessary materials were standard commercial chemicals. This included the isocyanate and polyol-urethane constituents of the polyurethane, as well as the Freon foaming agent, and the compressed nitrogen propellent, the latter available and purchased in Japan.

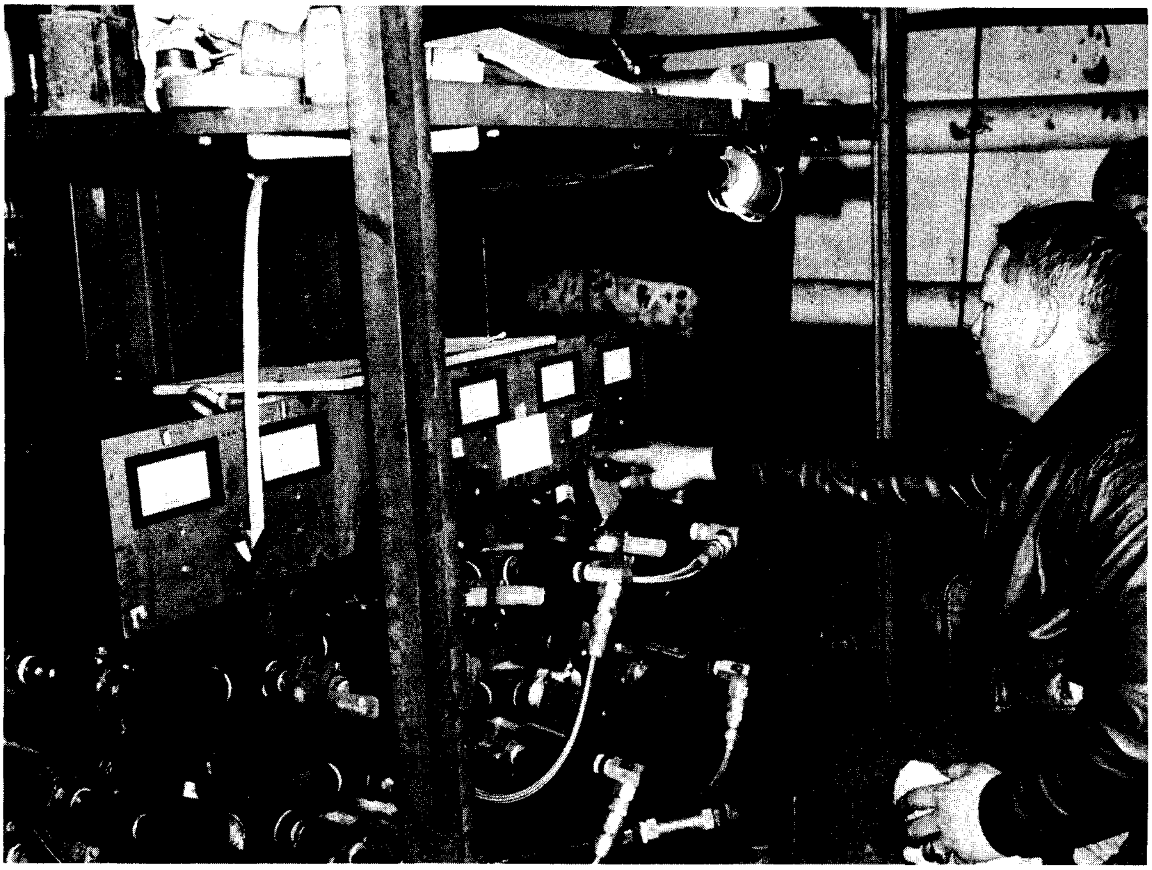


SCHEMATIC DIAGRAM OF FOAM SYSTEM



Components of the polyurethane foam operating equipment shown include polyol and isocyanate tanks, high pressure nitrogen flasks, connecting hose, and control panel.

FOAM EQUIPMENT SET UP ON TANK DECK OF LST

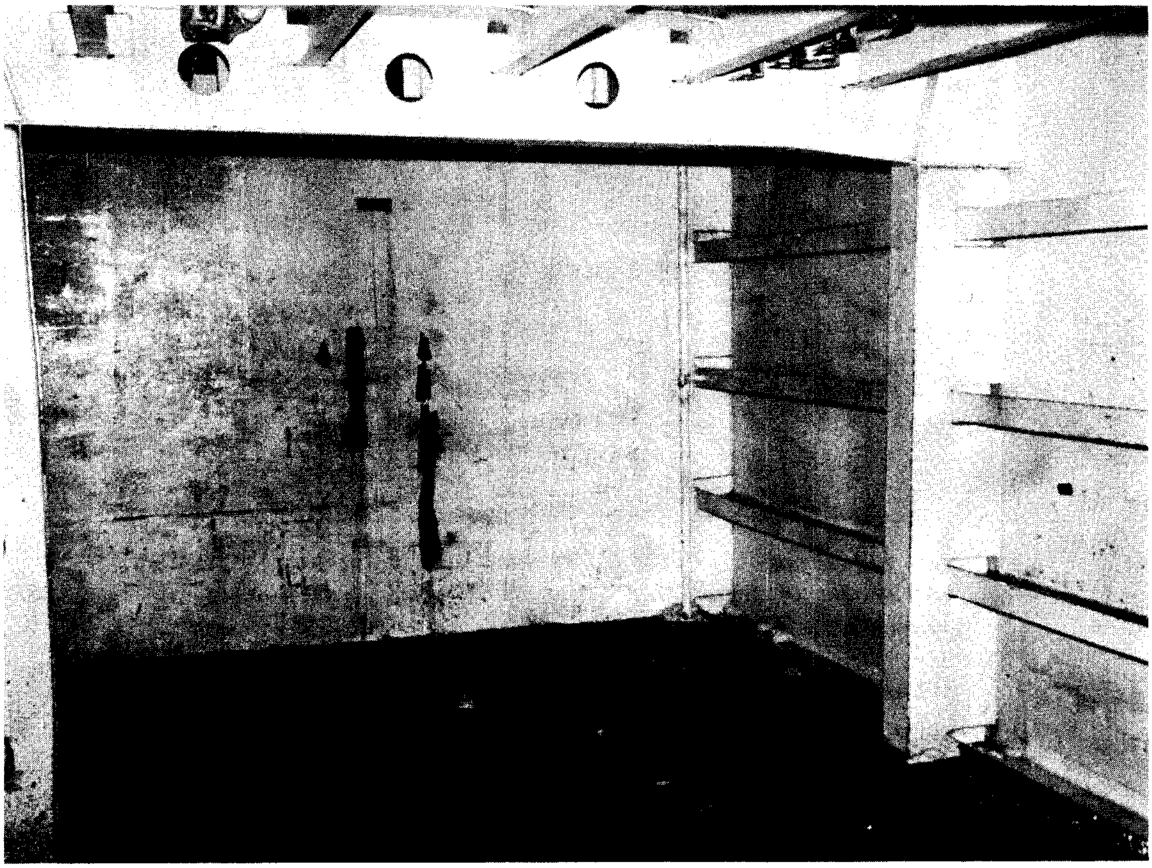


Murphy Pacific supervisor is pointing out significance of indicator readings to SRF personnel who assisted in the foam operation.

CENTRAL CONTROL PANEL FOR FOAM SYSTEM

Foam Installation Work

The work was undertaken at SRF Yokosuka, Japan, in February 1973, with the SUPSALV Representative serving as project engineer. Murphy Pacific, as stated earlier, provided special foaming equipment and technical supervision of SRF personnel. SRF Yokosuka provided workmen who were quickly checked out as foam gun operators, particularly in the techniques of continuous application of a single foam mass. SRF also provided riggers, laborers, and machinists to operate cranes, compressors, and other equipment. Proper installation of foam was crucial, not only to achieve proper buoyancy but also to provide a measure of shock mitigation.



Compartments to be foamed were cleaned and cleared of all loose gear. Releasing agent was applied to all surfaces to facilitate foam removal after operation requiring sink-proofing was completed.

LST COMPARTMENT SELECTED FOR FOAM INSTALLATION

All spaces below a waterline of 21 1/2 feet aft and 5 feet forward were selected for foam installation, with the exclusion of those compartments required for ship operation. The general procedure followed in each fore and aft section was to insert foam in the lower compartments first, then work upward to the second deck. Three independent foam dispensing heads, each with 275 feet of hose, provided a versatile application. All three units could be used in the same compartment or independently of each other. The ratios were controlled from the central control panel on deck, allowing constant quality control regardless of applicator location. Each unit was capable of applying 3,000 pounds of foam per hour. This involved implanting approximately 161,000 cubic feet of foam, weighing 495,000 pounds. Eleven days were allocated for the project, but in view of the urgency of the politico-military situation, crews worked around the clock and completed the work in 5 days.

ULTIMATE OPERATIONAL EMPLOYMENT

The WASHTENAW COUNTY, converted to MSS-2, was then deployed to the South China Sea to become a critical element of Operation ENDSWEEP. As such, she maneuvered uneventfully through the Haiphong Channel to successfully demonstrate that the area was free of the danger of underwater explosives.

CONCLUSIONS

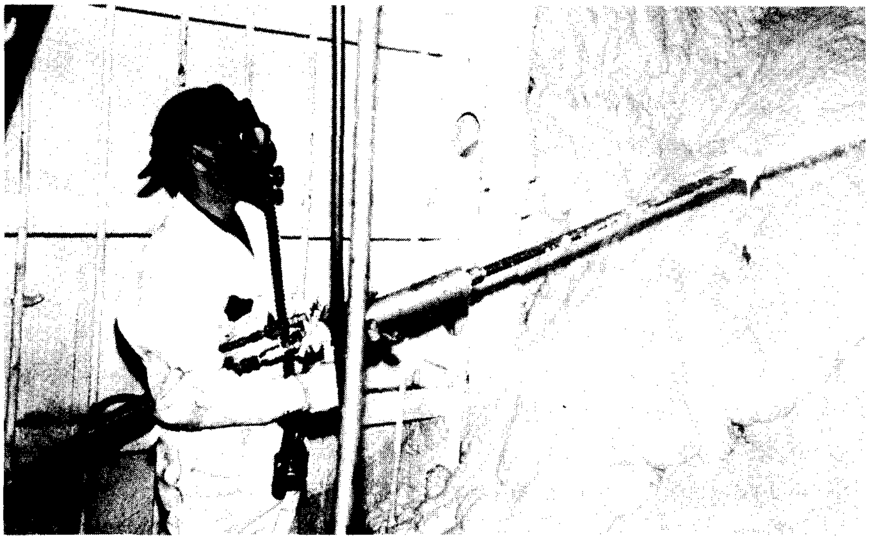
Foam-in-salvage was used effectively to provide permanently residual buoyancy for a "Guinea Pig" ship to positively demonstrate successful mine hazard elimination with minimum risk.

The operation demonstrated the ability of the Navy's salvage organization to rapidly and effectively mobilize its unique technology, when required, at the most distant Navy installations. The uniqueness of the non-salvage application on the other hand, was no greater, really, than the average salvage situation, when each operation is unique. Moreover, the time constraints of international politics were familiarly similar to those typically imposed on salvage by the sea and the weather.

The success of foam-in-salvage in providing positive residual buoyancy under the severe requirements of salvage enabled the technique to be used confidently in a non-salvage situation, to assure the safety of Navy personnel. It also insured the prestige of the United States in the event of an operational mishap. The glare of public embarrassment, had the test vessel been sunk, would surely have been well exploited by our nation's adversaries.

Foam gun is being directed through an access hatch as workman applies final amount of foam. Note blower supply duct used to reduce generated toxic fumes.

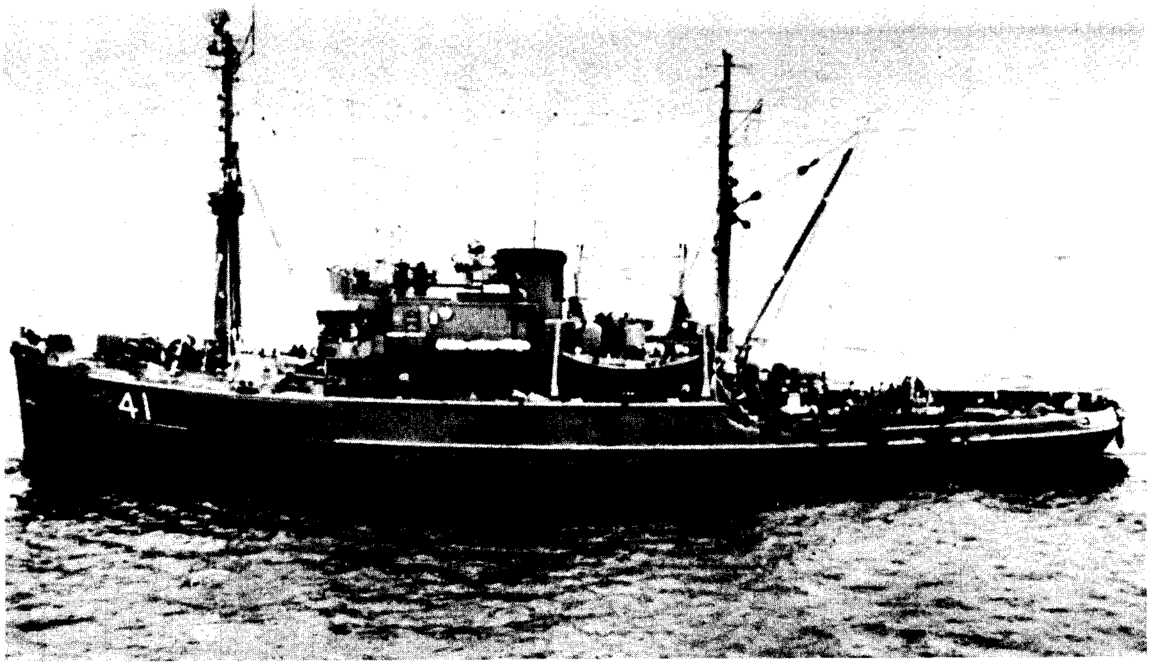
WORKMAN FINISHING FOAM APPLICATION OF A LOWER HOLD



SRF Yokosuka workman is applying polyurethane to LST compartment with foam gun. Note supply hoses connecting gun to foam system set up on LST's tank deck. Breathing apparatus is necessary when applying foam in enclosed spaces, for protection against toxic fumes of the foam mix.

WORKMAN APPLYING LIQUID POLYURETHANE FOAM

CLEARANCE OF TUG WRECK FROM CONEY ISLAND CHANNEL



At the end of October 1973, USS OPPORTUNE (ARS-41) successfully conducted operations to remove a wrecked tug hull obstructing Coney Island Channel, for the U.S. Army Corps of Engineers. The 214-foot OPPORTUNE is one of a class of 2040-ton salvage ships equipped with a variety of special equipment for diving and salvage. This includes large heavy duty sheaves built into the bow, over which a bow-lifting cable and sling can be rigged for heavy salvage lifts. It was used in this operation to retrieve the bottomed tug wreck.

USS OPPORTUNE (ARS-41)

CLEARANCE OF TUG WRECK FROM CONEY ISLAND CHANNEL

INTRODUCTION

Dredging of the Coney Island Channel, off New York Harbor, by the U.S. Army Corps of Engineers, required the removal of a 53-foot harbor tug, H.W. LONG, that was sunk bow down in the mud of the 30-foot channel bottom. USS OPPORTUNE (ARS-41) conducted a successful 10-day operation from 23 October to 1 November 1973, lifting, removing, and disposing of this navigational obstacle.

It was determined to raise the LONG off the bottom by means of chain slings under the tug's intact hull. This necessitated burrowing a tunnel under the tug's bow, which was substantially buried in the mud. The usual high pressure hose tunneling nozzles were relatively ineffective against the hard bottom. Ultimately, an air lift was tried and proved successful in providing the necessary tunnel for a messenger line.

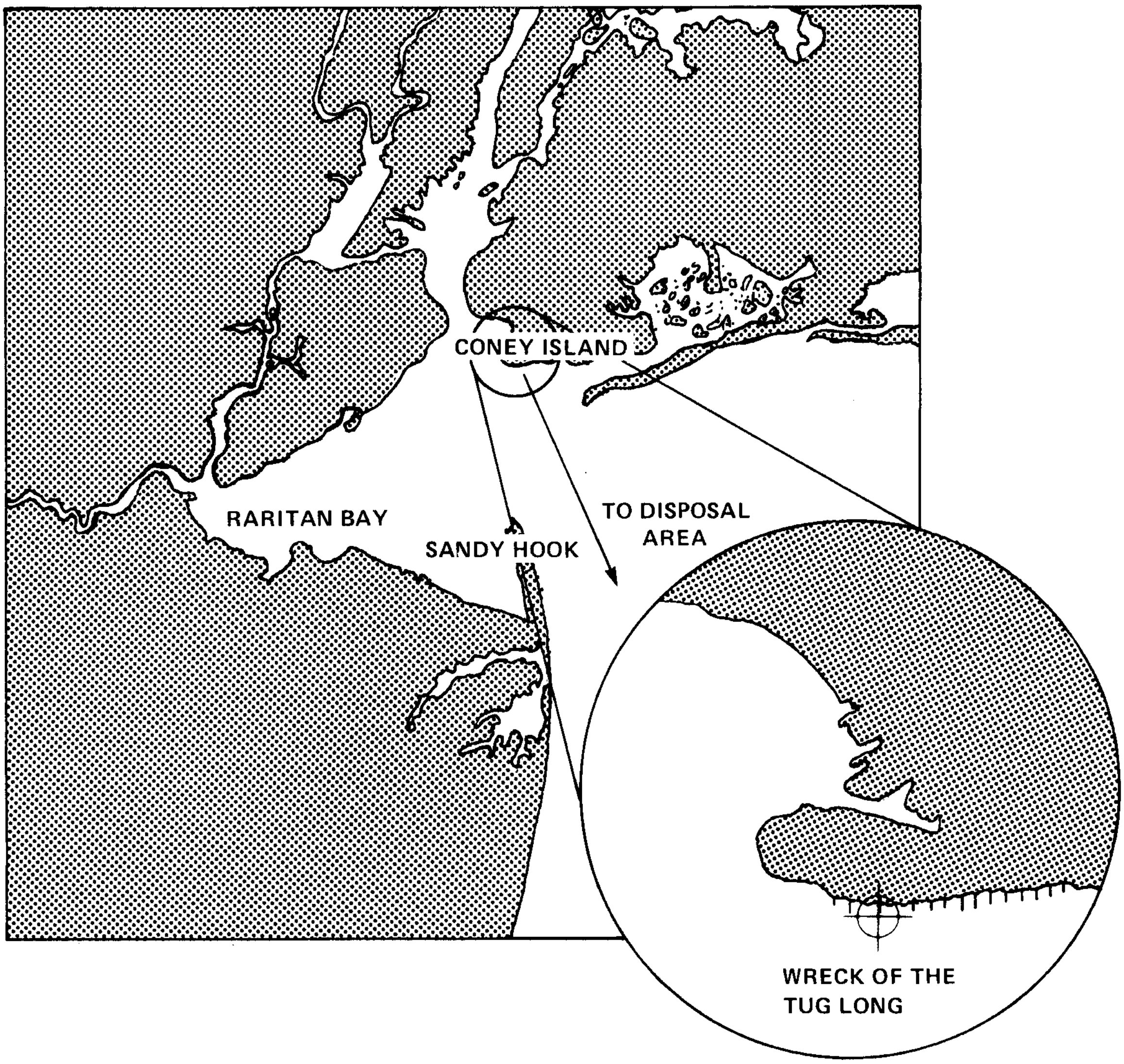
Once messengers could be passed under the bow and the relatively less obstructed stern, the cable and chain slings were hauled into position and properly secured. Then, on a suitable high tide, the sling cables were hauled in over the OPPORTUNE's bow sheaves, using the bow-lift purchase. With the tug in place under her bow, OPPORTUNE stood out to deposit the hulk safely in deep water.

SALVAGE REQUIREMENT

In October 1973, the harbor channel maintenance dredging under the U.S. Army Corps of Engineers, in the approaches to New York Harbor, was faced with the requirement of having the sunken hulk of the 40-ton tug, H.W. LONG, removed from the Coney Island Channel. Accordingly, the New York District Office sought Navy assistance. Commander, Service Squadron EIGHT in Norfolk, Virginia, responded by dispatching a diving team from Harbor Clearance Unit TWO to perform a site survey, and by deploying USS OPPORTUNE (ARS-41) to remove the wreck.

Wreck Situation

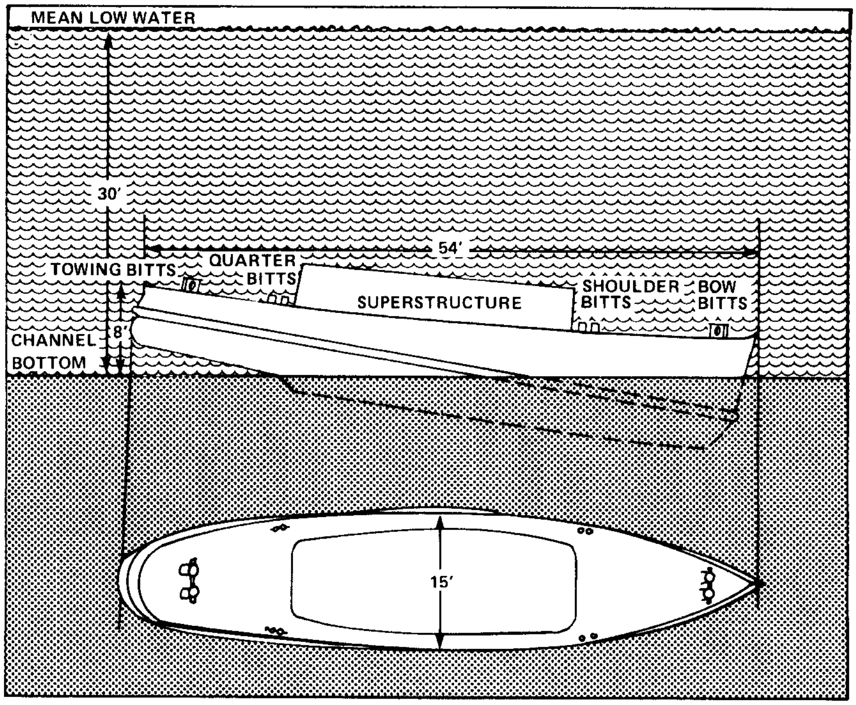
The survey conducted by Harbor Clearance Unit TWO determined that the 53-foot tug LONG was resting in a firm mud and shell bottom in 30 feet of water, at mean low water. The LONG was in an upright position, about 10° down by the bow, which was submerged



The sunken hull of the tug H.W. LONG was obstructing the Coney Island Channel and had to be removed to a disposal location designated by the Environmental Protection Agency (EPA), in the Atlantic Ocean.

LOCATION OF WRECK OF TUG H.W. LONG IN CONEY ISLAND CHANNEL

in the bottom mud. The steel hull appeared structurally sound, but covered with marine growth. Although internal survey was not performed, it did not appear at that time that the mud, in which the bow section was embedded, had penetrated the tug's steel hull. Upon completion of the survey, the wreck was marked with buoys, bow and stern, to facilitate OPPORTUNE locating the wreck and mooring for salvage operations.

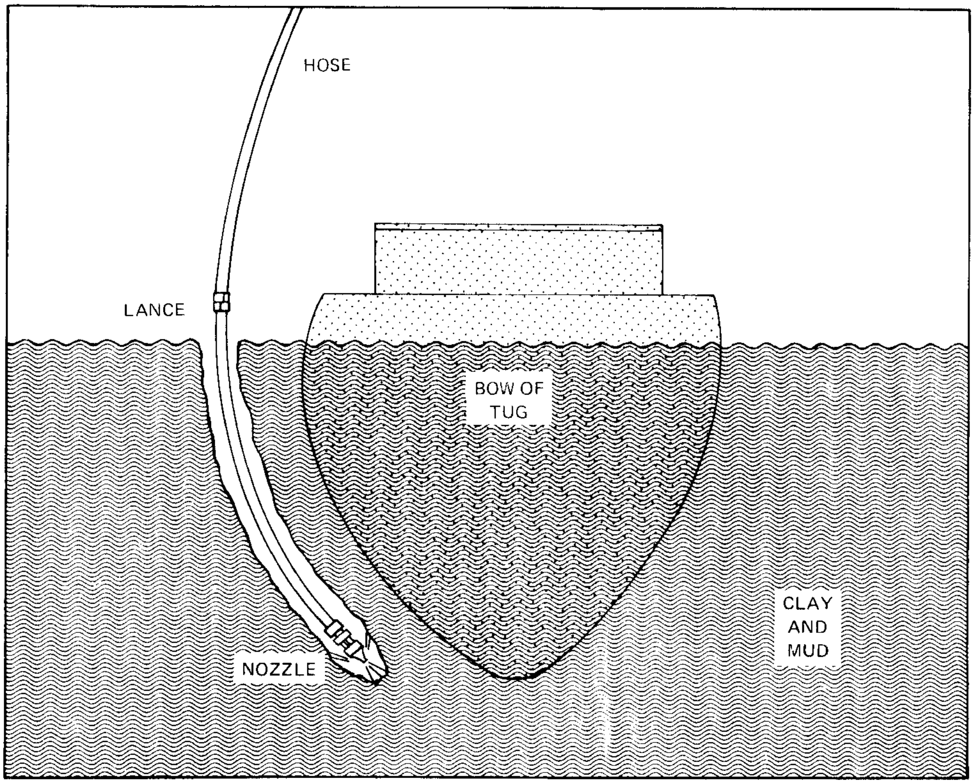


The steel hull of the H.W. LONG was sunk in the clay-mud bottom, down by the bow, which was half submerged in mud and gravel.

SITUATION OF WRECKED TUG IN CHANNEL BOTTOM

Approach

The size of the tug tentatively suggested a removal approach that would utilize the bow-lift capability of the OPPORTUNE. Heavy chain slings would be passed under the wreck, once tunnels had been cut through the mud under the wreck by means of a high pressure water lance. The lance consisted of a specially fabricated curved length of pipe powered by a high pressure fire hose. When the chain slings were in position, they would be secured against slipping, forward or aft on the tug's hull, by means of wire preventers. The forward preventers would be attached to shoulder bitts in the tug's deck forward, the after preventers to the quarter bitts on the tug's deck aft. Once rigged, the OPPORTUNE's



It was anticipated that a tunnel could be quickly cut under the LONG's bow for one of two chain slings. The hard clay of the channel bottom proved difficult for a variety of lance nozzles.

USING WATER LANCE TO CUT TUNNEL UNDER BOW FOR CHAIN SLING

bow-lift/beach gear purchase system would be used to tighten the slings by taking in on them over the bow sheaves of the ARS. Then, when the tug was raised sufficiently to clear the channel bottom, the OPPORTUNE would proceed to a deep water disposal site designated in the dumping permit issued to the Corps of Engineers by the U.S. Environmental Protection Agency. At this site the lifting slings would be tripped open and the tug released to the sea bottom.

Problems

Several problems were encountered that complicated the operation. Twice, for example, foul weather made it necessary for OPPORTUNE to cease operation at critical points, to slip her moor, and take shelter alongside Pier 94 in New York Harbor. Although weather could delay operations, the other difficulties were overcome by salvage skill and persistence. This was the case with several aspects of digging the tunnels through the bottom under the LONG.

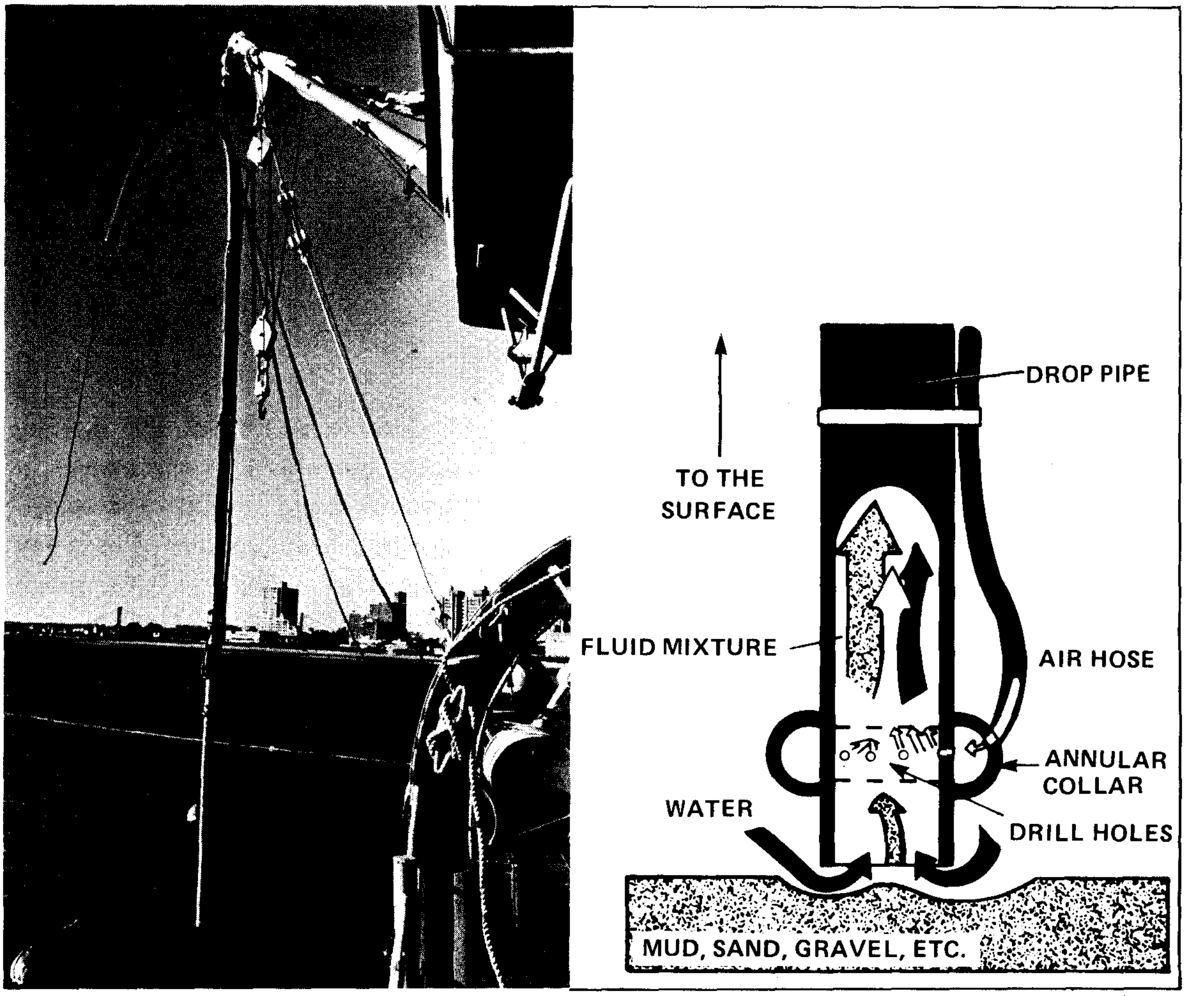
SALVAGE OPERATIONS

First Operating Phase

OPPORTUNE arrived at the salvage site on 23 October and spent the morning establishing a four-point moor. Divers commenced salvage operations in the afternoon, attempting to force a water lance under the stern of the wreck in order to pass a messenger line. Heavy gravel and hard packed sand impeded this work, which was completed next day. Using a Falcon nozzle, a 7/8-inch wire messenger was rigged under the stern. The tunnel under the bow was also completed, but the strong tidal currents of the channel kept washing back sand, gravel and debris. This problem continued next day when a combination peri-jet eductor modified with a 3-inch plastic hose as a suction discharge, plus a suicide nozzle lashed on the diver suction end, were used to tunnel under the bow from starboard. Meanwhile, another diver worked under the bow from portside with a Falcon nozzle. After 8 hours, this was successful and a nylon messenger was passed under the bow. Then, however, when the messengers were being used to pull pendants through the tunnels, bow and stern, the forward tunnel filled in and the nylon messenger parted. The after pendant, however, was successfully passed. At this point, increasing swells and pending heavy weather from tropical storm GILDA forced the OPPORTUNE to cease salvage operations and slip the moor to seek shelter at Pier 94, Port of New York.

Air Lift

Because of the problem of tunnel refilling, the in-port period on 26 October was used to fabricate a 6-inch air lift, and on 27 October, OPPORTUNE proceeded to NAD, Earle, New Jersey, to load a 600-cubic-foot-per-minute air compressor to drive it. Later in the day, OPPORTUNE arrived back at the salvage site and despite subsiding winds and sea from GILDA, took up the moor and again started work on the bow tunnel. Next day, 28 October, divers in deep sea gear manipulated the air lift to clean the bow tunnel of sand and debris, while others hand passed a 7/8-inch wire messenger. This was used to pass a 1-5/8 inch lift wire and a 2-1/4 inch chain, working with a combination of OPPORTUNE's after boom and a work boat. At this point, wind and seas again began to hinder operations



Several cutting nozzles were tried for tunneling under the LONG. They were found to be relatively inefficient due to tidal currents refilling the tunnels with sand, gravel, and debris. This problem was solved by employing an air lift, whose action is illustrated in the diagram.

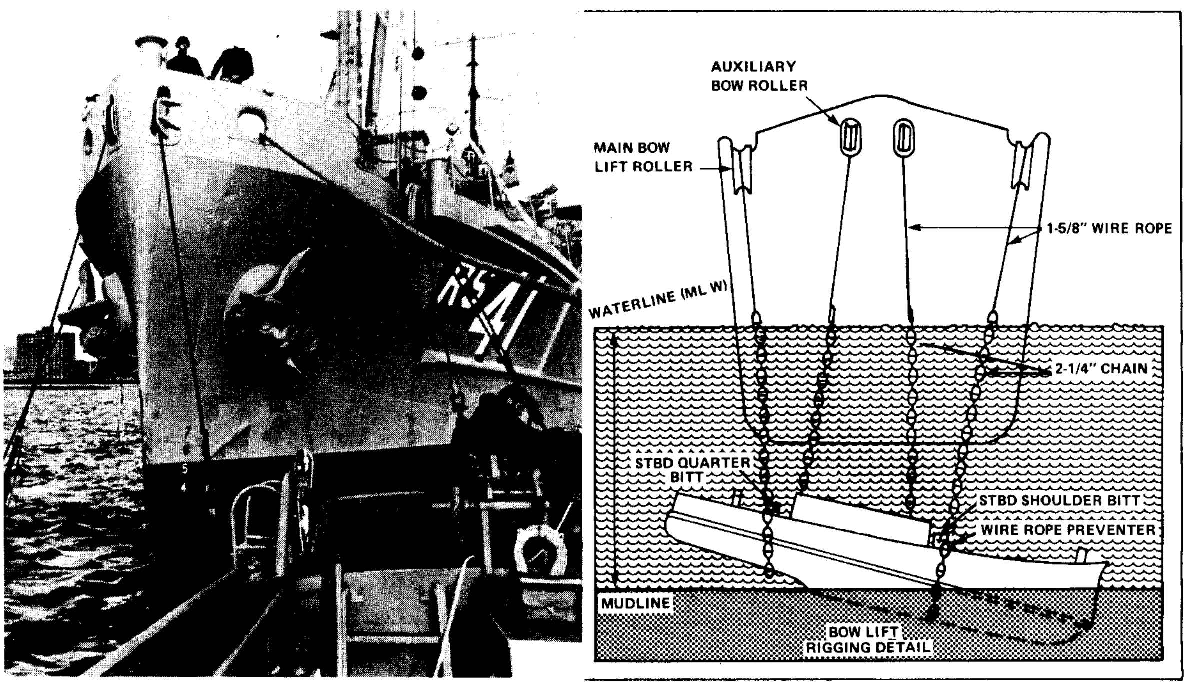
SIX-INCH AIR LIFT SOLVED THE PROBLEM OF CLEARING TUNNEL DEBRIS

and a fifth moor was placed on the port quarter. By evening however, 30-knot winds and flood tidal current were causing the port anchors to drag and OPPORTUNE once more was forced to take shelter in port at Pier 94.

Final Phase of Lift and Removal

After a day in port, OPPORTUNE was able to get back to the salvage site early on 30 October, working for a full day (until 2200) hooking up for lift of the wreck the next day. Starting early, 31 October, operations were again briefly interrupted – but for a good cause – when a passing commercial tug, BRONX, lost the second barge of a tandem tow. OPPORTUNE's work boats were dispatched to retrieve the barge, which was drifting out of channel, to where the BRONX could again take it in tow.

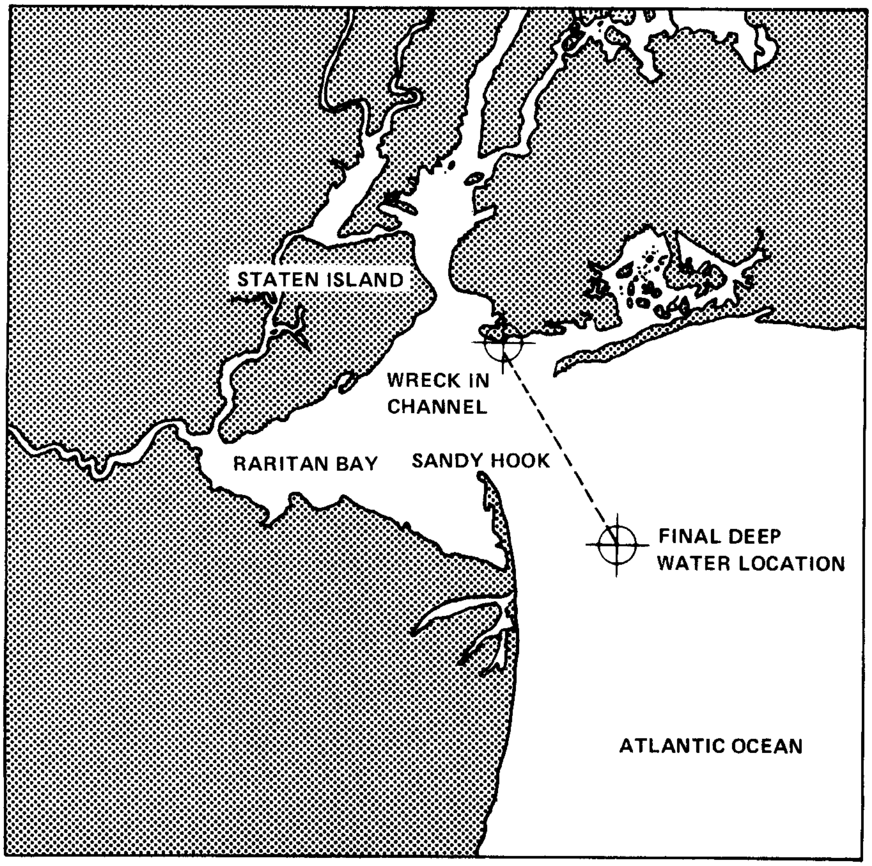
Operations then continued with OPPORTUNE using anchors to shift in the moor to take up a position bow-to, perpendicular to the wreck of the tug LONG to facilitate lift over OPPORTUNE's bow sheaves. Unfavorable wind and sea delayed commencing lift until 1600.



The OPPORTUNE lifted the tug LONG from the channel bottom, using port and starboard lift wires over her bow-lift purchase system.

THE BOW-LIFT PURCHASE OF THE ARS WAS USED TO LIFT THE TUG FROM THE BOTTOM

Slipping of the bow pendant required slacking off and repositioning before final lift could commence at 1800. The wreck broke surface at 1900 and was pulled snug, rolled around hull up, against OPPORTUNE's bow. The moor and all buoys were then retrieved, and at 2210, on a flood tide, OPPORTUNE got under way for the disposal ground, guided by Corps of Engineers channel maintenance personnel in avoiding critical shallow points. She then crossed Ambrose Channel at 3 knots, entered Swash Channel to avoid traffic, and stood out to sea. Speed was increased to 16 knots on reaching open sea. Swells and seas then increased to 6-8 feet and 4-8 feet respectively, and speed was reduced to 3 knots. Nevertheless, the wreck began working and chafing the lift pendants, and at 0324, the port



While proceeding to the designated deep water disposal site, increasing swells and waves caused the wrecked hull to work in the OPPORTUNE's lifting slings in which it was being carried. Ultimately, the cable of one of the slings parted and the remains of the LONG slipped out of the other sling. Fortunately, this occurred in suitably deep water, if a little short of the designated site.

OPPORTUNE MOVED THE LONG'S HULL TO DEEP WATER

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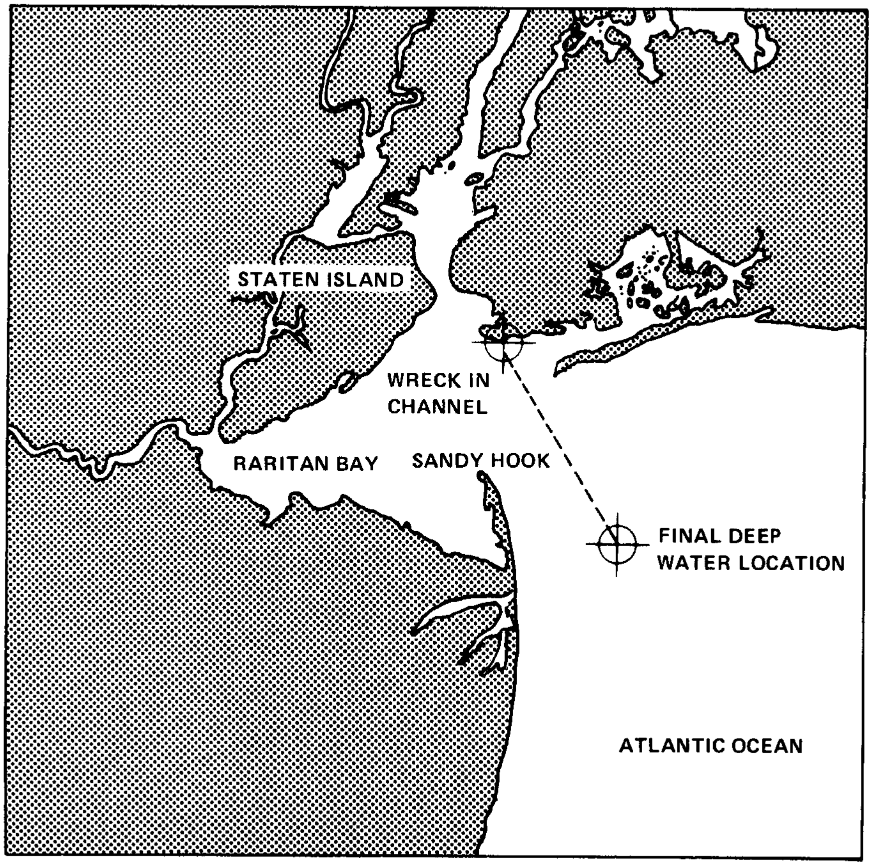

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OPPORTUNE MOVED THE LONG'S HULL TO DEEP WATER

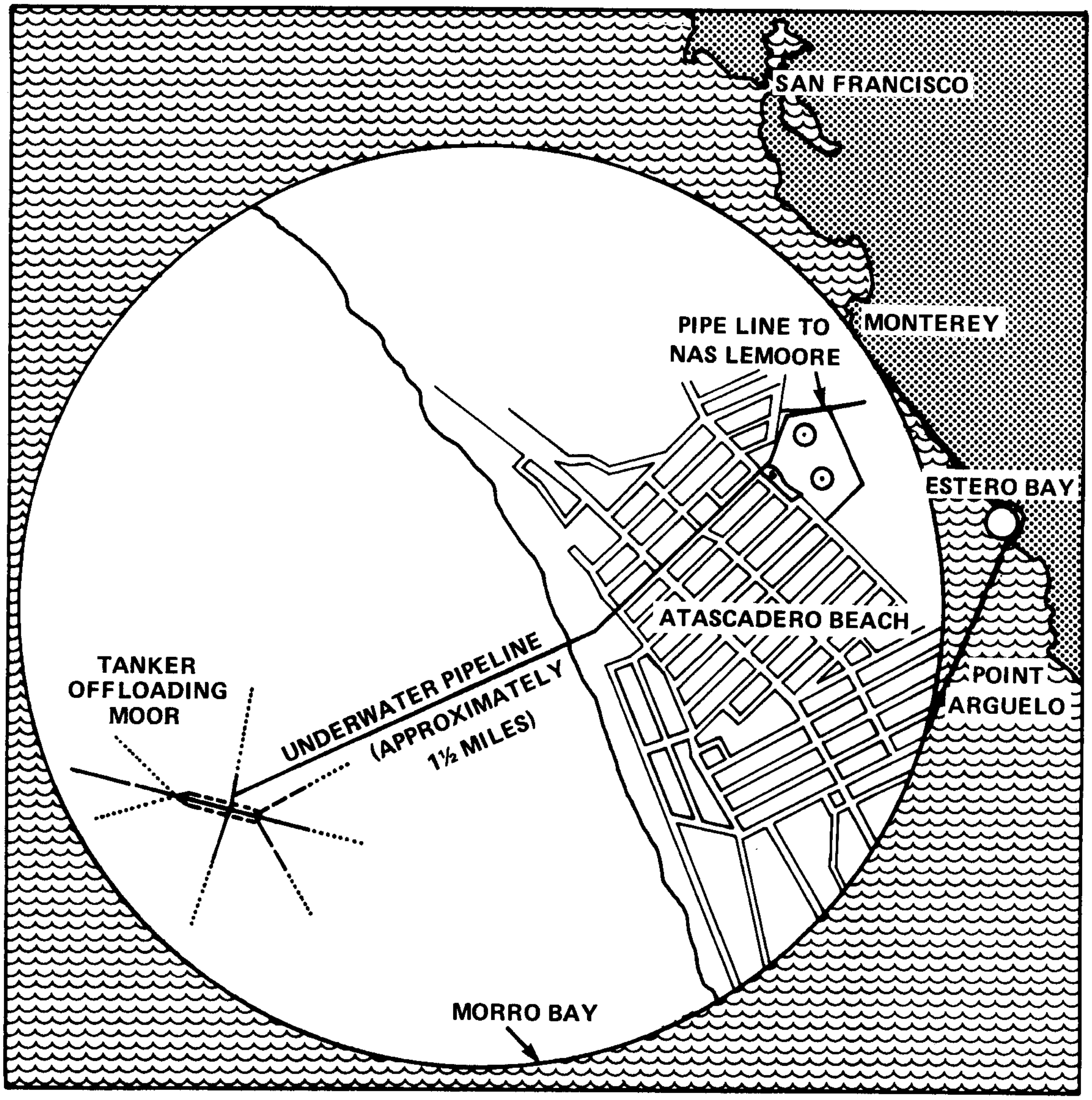
auxiliary 1-5/8 inch bow-lift wire flattened and parted at the port auxiliary bow roller. This released the hull of the wreck, since the stern also immediately slipped from the starboard sling, to plunge into 70 feet of water, about ten miles east of Asbury Park, New Jersey.

No personnel or material casualties were incurred and the tug was deemed to be in adequately deep water to no longer constitute a navigational hazard.

CONCLUSIONS

This is an example of a difficult, if uncomplicated, salvage task that was diligently and skillfully pursued despite weather, sea, and bottom conditions that continuously presented obstacles to successful completion. Each of the several intrusions by the unfavorable fall weather and currents of the New York Approaches were challenged to the limit of prudent seamanship. When the initial techniques chosen to provide bottom tunnels proved less than satisfactory, several variations were employed until the needed results were obtained. The on-board fabrication of an air lift, and the obtaining of a suitable non-allowance air compressor, represent the initiative frequently needed to successfully fulfill the missions of U.S. Navy salvage units.

REMOVAL OF FOULED GROUND TACKLE FROM DEEP WATER PETROLEUM OFFLOADING SYSTEM ESTERO BAY, CALIFORNIA



While seeking to moor for offloading the JP-5 fuel, the USNS SUAMICO fouled its anchor in the hose connection of the offshore POL pipeline. The installation serves to provide for tanker supply of fuel to NAS Lemoore, California by a pipeline connection from the Naval Fuel Annex, in the Morro Bay area of Estero Bay.

OFFSHORE FUEL MOORING, ESTERO BAY, CALIF.

REMOVAL OF FOULED GROUND TACKLE FROM DEEP WATER PETROLEUM OFFLOADING SYSTEM ESTERO BAY, CALIFORNIA

INTRODUCTION

On the evening of 6 November 1973, the USNS SUAMICO attempted to moor to a fixed POL buoy at Morro Bay, California. She dropped her port anchor to swing into the moor, and fouled the 12-inch offshore POL hose. Upon realizing that her anchor was fouled in the hose, SUAMICO was forced to slip her anchor and chain to prevent further damage. She reported the accident and departed the terminal.

Upon notification by the Supervisor of Salvage (SUPSALV), the SUPSALV representative, West Coast, immediately committed salvage and pollution control experts from the Murphy Pacific Marine Salvage Company. The salvage vessel, M/V GEAR, was sent to Morro Bay with necessary personnel and equipment to free and recover the anchor and chain that had fouled the POL hose and to repair or replace the broken hose.

The Murphy pollution control team deployed oil containment boom, obtained from the Navy Pollution Response Center, San Francisco, as a preventive measure. Divers from the GEAR burned the SUAMICO's anchor loose from its chain, enabling it to be disentangled from the POL hose and raised to the deck of M/V GEAR. With the POL hose connected to shore tanks, the salvage team then back-flushed 400 barrels of the JP-5 fuel from the hose without loss or spillage. Installation of a new POL hose and recovery of the anchor chain concluded the work successfully. This operation averted an oil pollution incident while concurrently making necessary repairs in an efficient and expeditious manner.

BACKGROUND

Nature of the Accident

On 6 November 1973, the USNS SUAMICO (T-AO-49) was proceeding into a fixed offshore POL unloading moor at Morro Bay, California, and dropped her port anchor to swing into position. SUAMICO, operated for the Military Sealift Command (MSC) by Hudson Waterways Corporation, carried JP-5 fuel for transfer to the overland pipeline connection at Naval Fuel Depot Annex, Estero Bay, for Lemoore Naval Air Station, 100 miles inland. In the process, the anchor dragged and fouled the 12-inch off-leading hose. Realizing what had happened SUAMICO slipped her anchor and chain to prevent further damage and reported the accident before departing the area.

Commitment of SUPSALV Resources

Supervisor of Salvage assistance was requested to free and recover SUAMICO's anchor and chain, prevent possible oil pollution, and repair the possibly damaged POL line. The SUPSALV West Coast representative immediately alerted the Navy's contractor, Murphy Pacific Marine Salvage Company, which mobilized the necessary assets and deployed them to the scene in Estero Bay. These assets included the Navy salvage vessel M/V GEAR, 2,500 feet of offshore oil containment boom, project manager, and personnel necessary to do the job. At the time, GEAR was engaged in work for the Naval Civil Engineering Laboratory (NCEL). Accordingly, GEAR's commitment to NCEL was cancelled. Early the next day, 7 November, she returned to Port Hueneme, offloaded NCEL personnel and equipment and got under way for Morro Bay.

PRELIMINARY ACTIVITY

Damage Survey Team

A salvage master had been ordered to proceed overland to the Estero Bay Fuel Annex with a salvage foreman and diver. They arrived the afternoon after the accident and met with personnel from the Annex, Estero Bay and the SUPSALV West Coast representative. A plan for the operation was discussed, including removal of the anchor without further damaging the offshore POL array, and the prevention of possible oil pollution. It was concluded that an oil boom should be used to contain any fuel should a spill occur.

Shipment of Oil Containment Boom

On the evening of 7 November, Murphy Pacific completed steps to ship the oil containment boom from the Navy warehouse at San Leandro, California, to the scene of operations 235 miles south. The project manager and two warehousemen had reported to San Leandro and contacted various trucking companies. Bigge Drayage Company provided the most immediate response and had two flat-bed trucks at the warehouse by 2000. The remaining trucks needed were ordered, and at time intervals commensurate with loading requirements, 23 sections of assembled oil containment boom were loaded and dispatched by 0600, 8 November. The trucks which had first loaded on the evening of 7 November arrived at Morro Bay by 0600, 8 November with the first sections of oil boom.

SALVAGE OPERATIONS

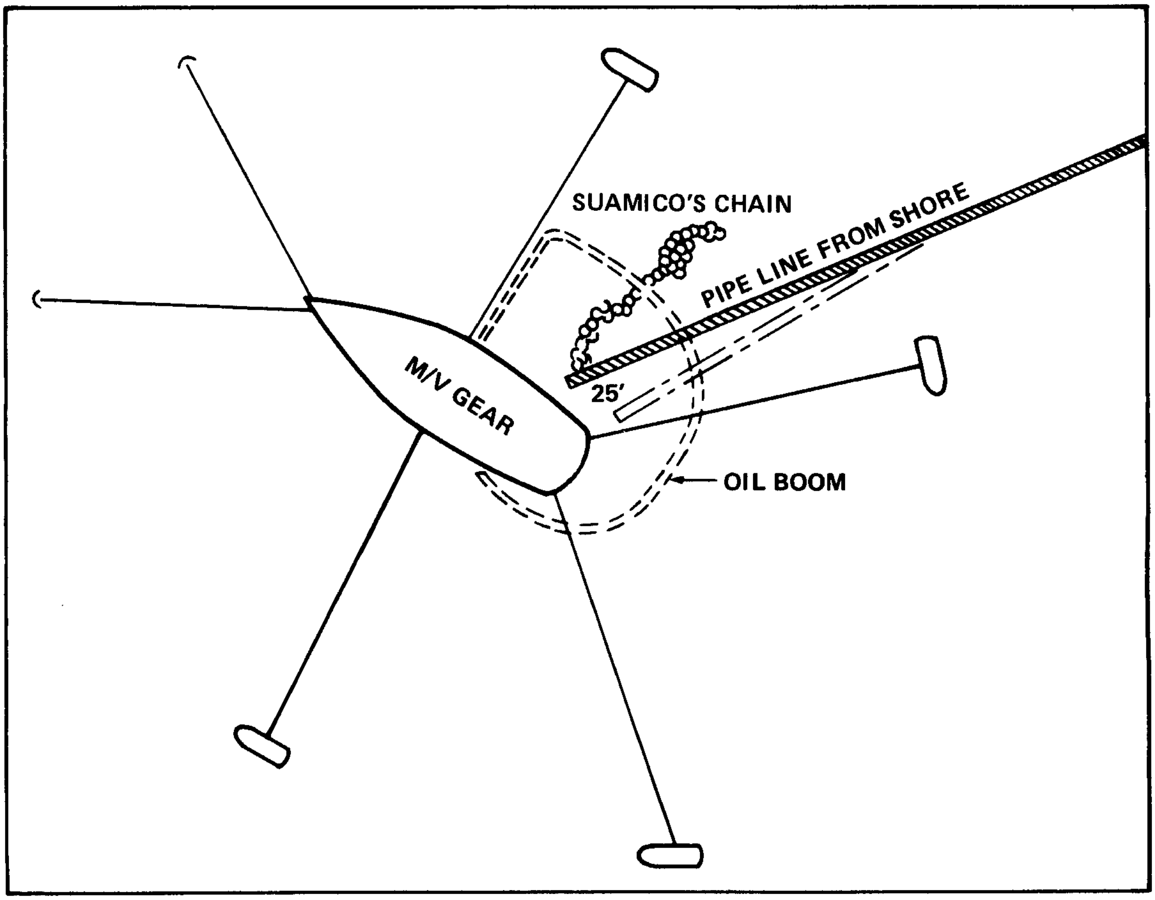
Initial Work on Offshore POL Line

The M/V GEAR arrived at Estero Bay on the evening of 7 November and anchored awaiting first light. On the morning of 8 November, assisted by the local tug CAYUCOS, GEAR moored over the end of the fuel pipe in a moderate NNW swell. Divers went down to inspect the pipe, hose, and fouled anchor and to install a marker buoy. They also removed a spar buoy, along with its anchor and chain, that had been used to mark the end of the pipe. Then, after a diver had burned the anchor of the SUAMICO from its chain, the anchor was disentangled from the POL hose and raised to the deck of the M/V GEAR.

Deployment of Boom

On shore, operations were proceeding to deploy the oil boom to the accident site. A pier area was leased, local crane and forklift services were secured, and laborers were hired. Offloading of the boom, and deployment, began at 1300, 8 November. By evening, 300 feet of boom had been assembled, towed five miles to the scene of operations, and secured to the moor adjacent to the M/V GEAR. When the tug returned to the pier area, an additional 150 feet had been assembled and launched next to the pier. However, operations had to be secured for the night because there was only one crane operator and the light had become inadequate.

The tug CAYUCOS arrived with another section of oil boom and it was deployed with the assistance of GEAR's work boat. A final section of oil boom was delivered at 1255. The entire boom was secured to the GEAR's mooring line at one end and to SUAMICO's abandoned anchor chain, by means of an 80-foot wire, at the other.

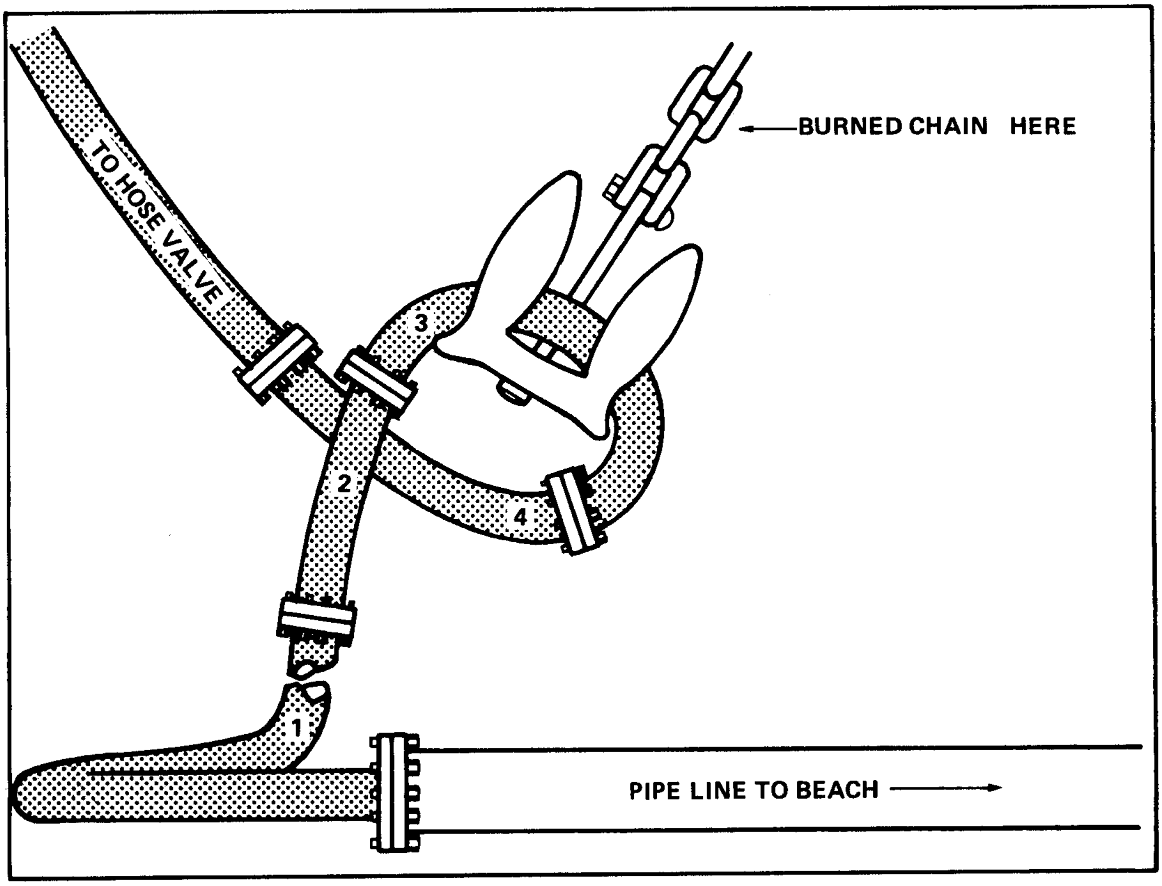


The assigned salvage ship, M/V GEAR, moored at the oil unloading installation to free the SUAMICO's anchor. Oil containment boom was set out against release of JP-5 jet fuel as a consequence of working on the fouled pipeline and hose.

MOORING OF M/V GEAR WITH DEPLOYED OIL CONTAINMENT BOOM

POL Line Recovery and Back-Flushing

On the morning of 9 November, a diver made another survey of the hose and pipe at the scene of the casualty. With SUAMICO's ground tackle clear, work could now begin to permit back-flushing of the fuel line to shore tanks. At 1353, a diver secured a wire to the valve head, and at 1405 GEAR began heaving-in the end of the POL hose on deck. After the tangled lift wire was cleared from the valve head and buoy, the flange on the valve head was connected up to permit back-flushing of the fuel line.



SUAMICO's anchor was fouled on a twisted bight of the fuel hose. It was necessary to cut the anchor chain to free the anchor before raising it.

DETAIL OF FOULED ANCHOR AND FUEL HOSE

Fire hoses were laid out, and precautionary measures were taken to prevent and combat fire. At 1717, the work boat got under way to check for leaks while the hose was back-flushed. At 1740, the valve at the beach end was opened, and back-flushing from the GEAR to the shore commenced, using 90 pounds of water pressure. A diver continuously checked the hose and pipe for leaks. At 1810, it was reported that fuel was being received on the beach. At 2145, back-flushing was secured for the night. The valve was secured and the hose lowered to the bottom.

On the morning of 10 November at 0800, with a moderate to large NW ground swell, flushing of the pipeline to the beach resumed. A diver continued to survey the hose and pipe for leaks. By 0900, flushing was secured with the report from the beach that the hose and pipe were clear of all fuel. Four hundred barrels of JP-5 had been flushed from the hose without spill or loss. At 0920, the valve head was removed, and personnel began disconnecting the 25-foot hose sections.

Removal of Oil Boom

With the danger of oil pollution over, the oil boom was released, and at 1030 the tug CAYUCOS got under way to tow it ashore. However, she encountered a 7-knot current at the mouth of the channel and was unable to make headway. Accordingly, the tug ALMA and the GEAR's work boat had to be called to assist in the tow. At 1400, the boom was safely returned to the pier area, and by 1730, it was out of the water. Loading the boom on trucks for return to the warehouse was completed the following day.

Removal and Inspection of Fuel Hose

In the meantime, disassembling the 25-foot sections of fuel hose continued. At 1400, the eighth and last hose section was free from the pipeline and at 1445, was on the deck of GEAR. At 1624, a diver was sent down to attach a flange on the pipe and preparations were made for a pressure test. At 1715, a 150 pound hydrostatic pressure test was placed on the pipe to the beach. At 1815, a fifteen pound pressure drop occurred. It was found that the flange on the pipe was leaking and a diver tightened it. At 1820, the pipeline was re-pressured to 150 pounds and held for an hour. The salvage crew then secured at 2015.

First Installation of Rehabilitated Hose

On the morning of 11 November, there was moderate to heavy WNW swell. At 0930 GEAR was secured in a 5-point moor. At 1015, installation of a new fuel hose began. Three divers were sent down in the afternoon to connect the hose to the pipe. After a final check on the hose-to-pipe hookup, operations for the day were secured at 2000.

On the morning of 12 November, in a moderate to heavy SSW swell, hooking up of various sections of the hose continued. At 0825, No. 5 section was discovered to have a cut in the side. It was disconnected and brought back on board and, at 1000, the pipeline and remaining four sections of hose were filled with water and given a hydrostatic test to 100 psi.

Hydrostatic Tests

At 1200, a decision was reached to remove all hose and take it to Port Hueneme for hydrostatic tests. Accordingly, the divers disconnected the hose from the pipe and placed a blank flange on its end. At 1345, all hose was on deck. With the assistance of the tug ALMA, GEAR broke her moor, and at 1630, got under way for Port Hueneme.

On the morning of 13 November, GEAR moored to Wharf No. 3, Port Hueneme and began offloading 11 lengths of hard rubber hose for visual inspection and hydrostatic test. At 1520, GEAR also offloaded USNS SUAMICO's abandoned anchor to a flat-bed truck for delivery to San Pedro.

At 1600, GEAR began re-loading five hoses that had passed the hydrostatic test, and one section for return to San Pedro. At 2000, GEAR got under way from Port Hueneme for Estero Bay.

Section Installation of Hose to Offshore Pipeline

On the morning of 14 November, with the assistance of the tug CAYUCOS, GEAR again maneuvered into mooring at Morro Bay. At 0840, she was taut in a 5-point moor over the end of the hard pipe. A diver went down to remove the blank flange from the end of the pipe, and at 0935, workers began bolting hoses together. Hookup of the hose to the hard pipe was completed at 1445. At 1700, the tug CAYUCOS was alongside with the spar buoy and a diver replaced the spar buoy anchor by 1725. The hose then was raised to the ship's side, and a test plate made fast to the end for hydrostatic test. The test was continued from 1800 to 2000 hours, and at 2030, work for the day was secured.

Recovery of SUAMICO's Anchor Chain

On the morning of 15 November, a diver from the GEAR went down to attach a wire to the end of SUAMICO's abandoned anchor chain and at 0855, GEAR began maneuvering in her moor to recover it. At 1115, all of SUAMICO's anchor chain was aboard on the after deck and by 1204, GEAR got under way for San Pedro. At 0830, 16 November, GEAR arrived at San Pedro and offloaded SUAMICO's anchor chain.

Final Installation of Hose

On 26 November 1973, GEAR was under way again at 1400 for Morro Bay, having previously loaded the three additional sections of fuel hose needed there. GEAR arrived at 0740, 27 November, and with the assistance of the tug ALMA, she again maneuvered into a 5-point moor. A diver went down to attach a wire strap to the end of the hose and the rubber fuel hose was brought up to the rail to hook up the additional three sections. At 1130, the additional sections had been connected and a test flange was hooked up to the end of the hose to begin pressure test on the fuel line. The line was then satisfactorily tested at 150 pounds pressure for about an hour. The test flange was then removed, an overhauled ball valve was mounted on the end of the hose, and the hose was lowered to the bottom. After this, a diver was sent down to inspect the hose and buoy position, which were found satisfactory.

With the assistance of the tug ALMA, GEAR began to break her moor at 1447. At 1512 she was under way for Port Hueneme, where she arrived at 0818 the following morning, 28 November. The concerted effort and expertise of all personnel involved had completed the necessary repairs while averting any sort of oil spill incident.

CONCLUSIONS

This incident involved three different subtasks, all effectively dealt with: the deployment of POL containment boom to prevent pollution; the recovery of jettisoned anchor and chain; and the repair of seabed-installed POL equipment.

The oil spill prevention measures, fortunately, proved to be unnecessary. Nevertheless, with the possibility of releasing over 2,000 gallons of low viscosity, kerosene-like JP-5 into the sensitive California marine environment, this wise precaution was a primary consideration. It is a good example of the interaction of salvage operations and spill containment.

The SUAMICO's anchor and chain constituted a routine recovery that the Navy's salvage forces are frequently called upon to perform. It was complicated by involvement with a POL system and the ever-present possibility of oil spill and environmental pollution. The problems were balanced in some measure by the absence of need for a difficult and time-consuming search for the lost ground tackle.

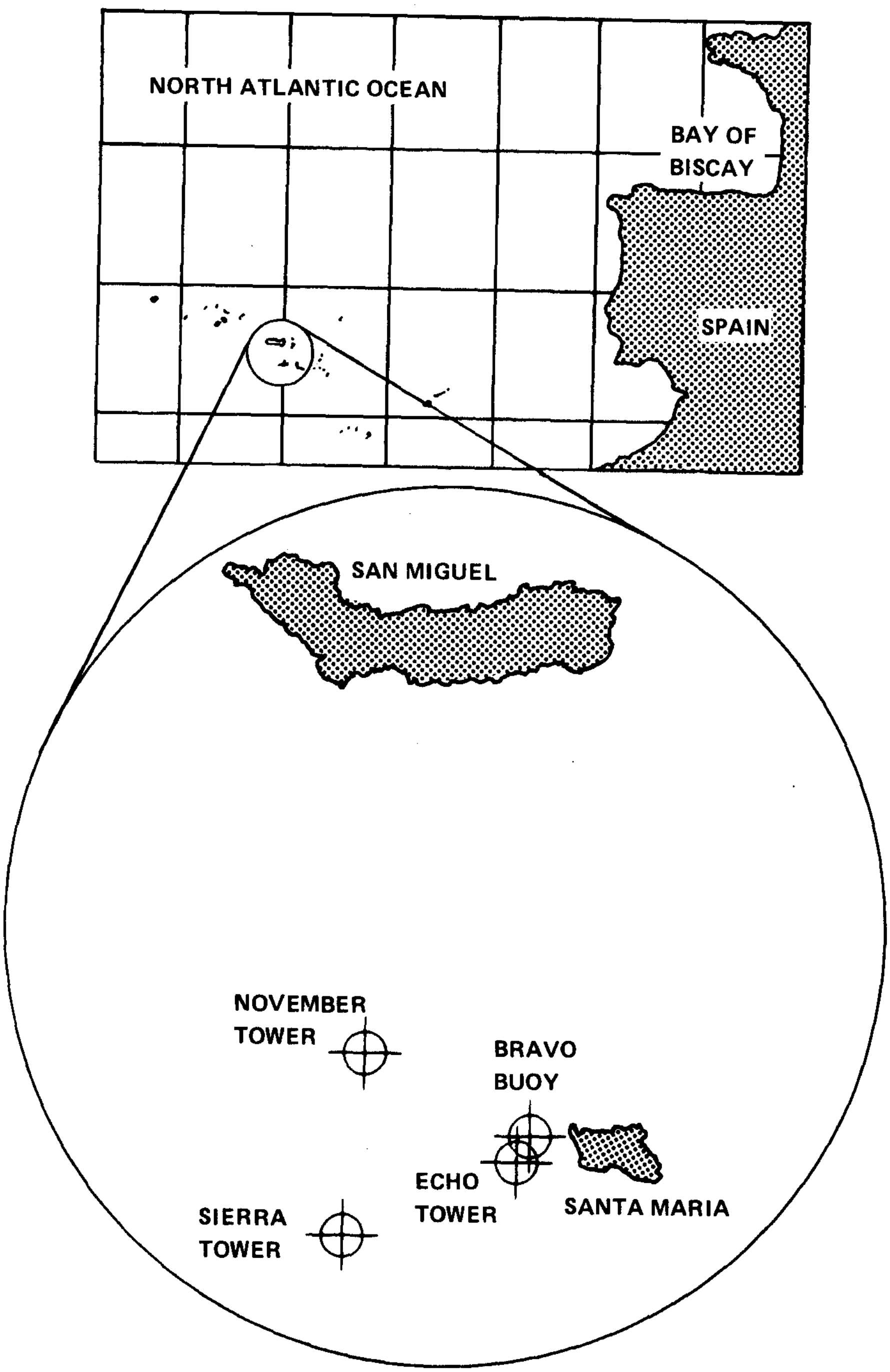
The final element of this operation, which may presage the future occurrence of such tasks, was the requirement to recover, repair, test and reinstall an offshore POL system. The effectiveness and efficiency of offshore loading and unloading of POL is leading to an increase in the number of such installations. The statistical occurrence of failure and accident in any activity makes future damage to such equipment seem not unlikely. It is to be hoped that the constantly increasing offshore activity of the petroleum industry will be a source of new and refined techniques for dealing with such problems.

1973 OPERATIONS

IN SUPPORT OF THE

AZORES FIXED ACOUSTICAL RANGE

(AFAR 73)



AFAR is an acoustical detection system of three towers, NOVEMBER, ECHO, and SIERRA, mounted on seamounts off the Azores, as well as a subsurface environmental monitoring buoy, BRAVO.

AZORES FIXED ACOUSTICAL RANGE (AFAR)

1973 OPERATIONS
IN SUPPORT OF THE
AZORES FIXED ACOUSTICAL RANGE
(AFAR 73)

INTRODUCTION

In July 1973, the Director of Ocean Engineering conducted a sequence of operations in support of the Azores Fixed Acoustic Range (AFAR), a NATO ocean surveillance resource. Technical laboratory support was provided by the U.S. Naval Underwater Systems Center (NUSC) New London, Connecticut. Ocean engineering support was provided by Ocean Search, Inc., an ALCOA Subsidiary, under contract to the Supervisor of Salvage. This work had commenced with the initial installation in 1970, and had continued in the good summer weather of 1971 and 1972.

The 1973 operations consisted of four tasks:

- *properly reorienting one of the three 120-foot-high acoustic-array towers, mounted on the sea bottom at 1,000 feet;*
- *repairing and refurbishing a 5,000-pound underwater environmental monitoring buoy, moored 200 feet below the surface;*
- *addition of a NOMAD weather-type buoy to the system;*
- *calibrating the AFAR system and each of its major elements.*

The project was smoothly executed in two weeks of actual on-site operations that were significantly facilitated by Ocean Search, Inc.'s unique research ship ALCOA SEAPROBE. Detailed planning by SUPSALV, NUSC, and Ocean Search Inc.; at-sea rehearsals, material readiness, availability of back-up equipment; and, employment of experienced ocean engineering personnel – all combined to establish AFAR to a level of 100% of effectiveness.

AFAR BACKGROUND

Components of the AFAR Range

The Azores Fixed Acoustical Range (AFAR or AFAR range) is a deep water acoustical system planted on the ocean bottom, 12 to 25 nautical miles east of the island of Santa

Maria on the Azores. It consists of an underwater transmitter tower – ECHO, to the east; two underwater receiving towers – NOVEMBER and SIERRA, located to the north and south; a subsurface ocean environment measuring buoy – BRAVO; and, a laboratory on the island of Santa Maria. The towers are positioned on underwater peaks 1,000 to 2,600 feet below the surface. Buoy BRAVO is subsurface-moored at 200 feet below the surface. Submarine cables connect these components.

AFAR is sponsored in varying degrees by eight NATO nations, with the United States and France being responsible for range installation. Initial implantment operations conducted out of Ponta Delgada, San Miguel, during the summer of 1970, did not result in a usable facility. Consequently, AFAR operations were conducted during the summer of 1971 in order to complete establishment of the range. Three major tasks were involved in these 1971 operations: to retrieve, repair, and reimplant ECHO tower; to implant BRAVO buoy; and, to repair the receiving cables on NOVEMBER and SIERRA towers. The 1973 operations were aimed at completing all these arrangements and putting AFAR into proper operating condition.

Acoustic Antennas

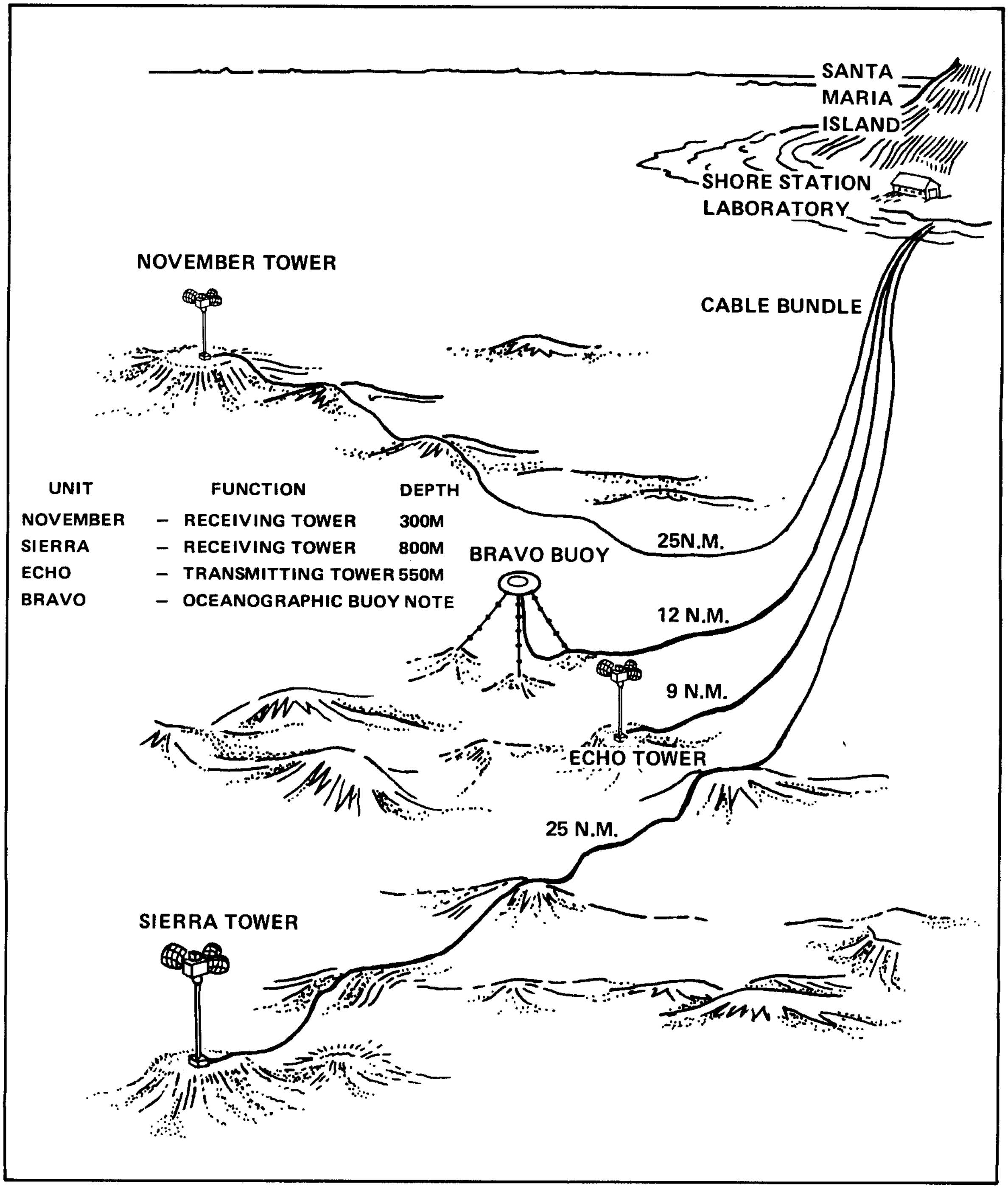
The acoustic antennas mounted on the towers are the heart of the AFAR range. They are the first broadband directive antennas built for deep ocean implantment and they range in size from 12 to 22 feet in diameter. These antennas constitute novel engineering in several aspects: band widths, lightness, and the pressure compensation system. They are also the first antennas to be mechanically steerable in both planes.

Antenna Towers

The towers that support the acoustic antennas are 100 feet high. When assembled, each antenna tower is 120 feet long and 40 feet wide. Each weighs 72 tons in the air, 6 tons in the water, and has a dynamic mass in water equivalent to 120 tons. Each tower has a lifting eye for attaching the lowering cable used during implantment or repositioning.

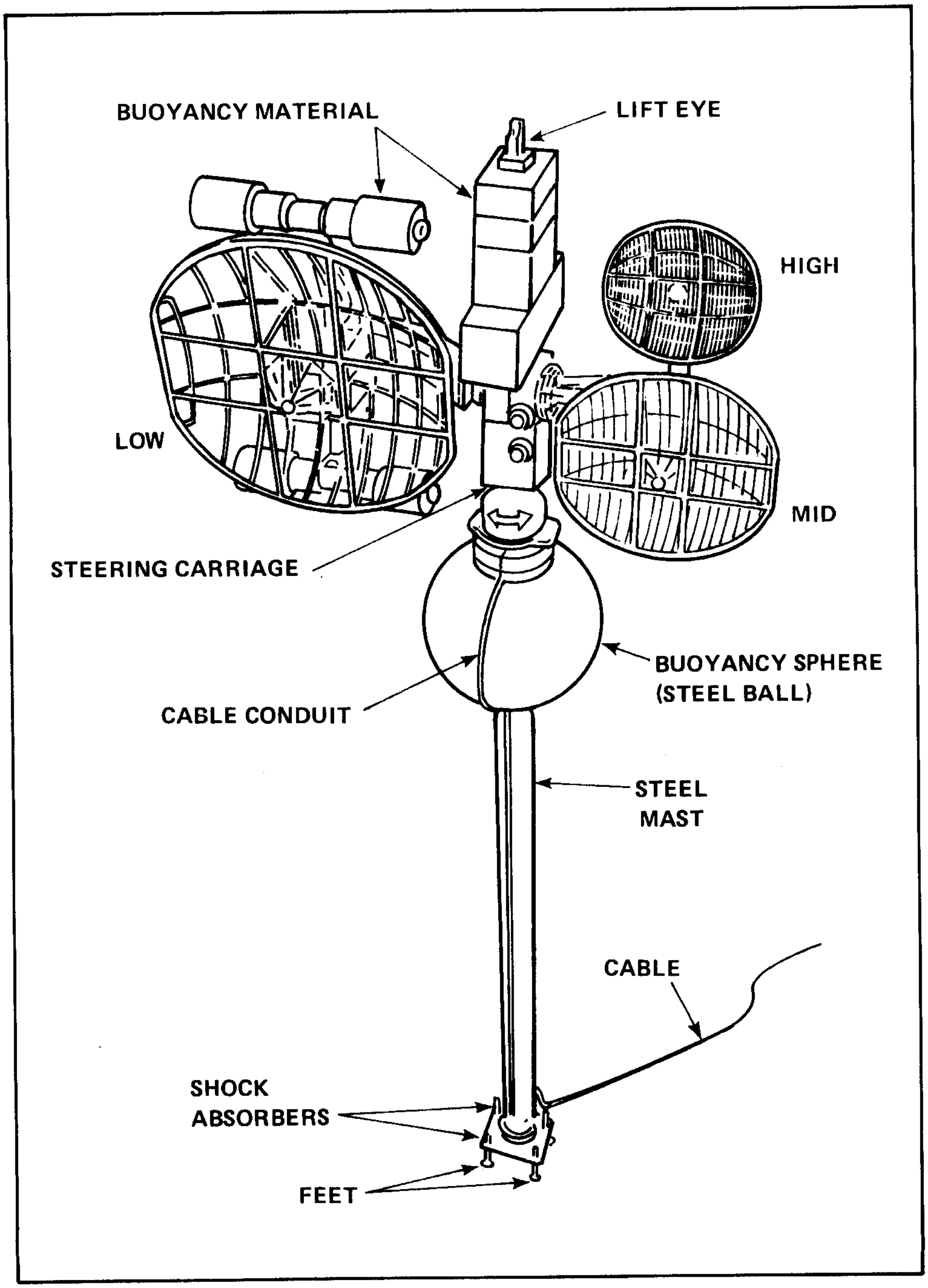
BRAVO Buoy

The subsurface ocean environment measuring buoy, BRAVO, is 13 feet in diameter, 13 feet high, and weighs 2 1/2 tons in air. It was built by the United States at the Naval



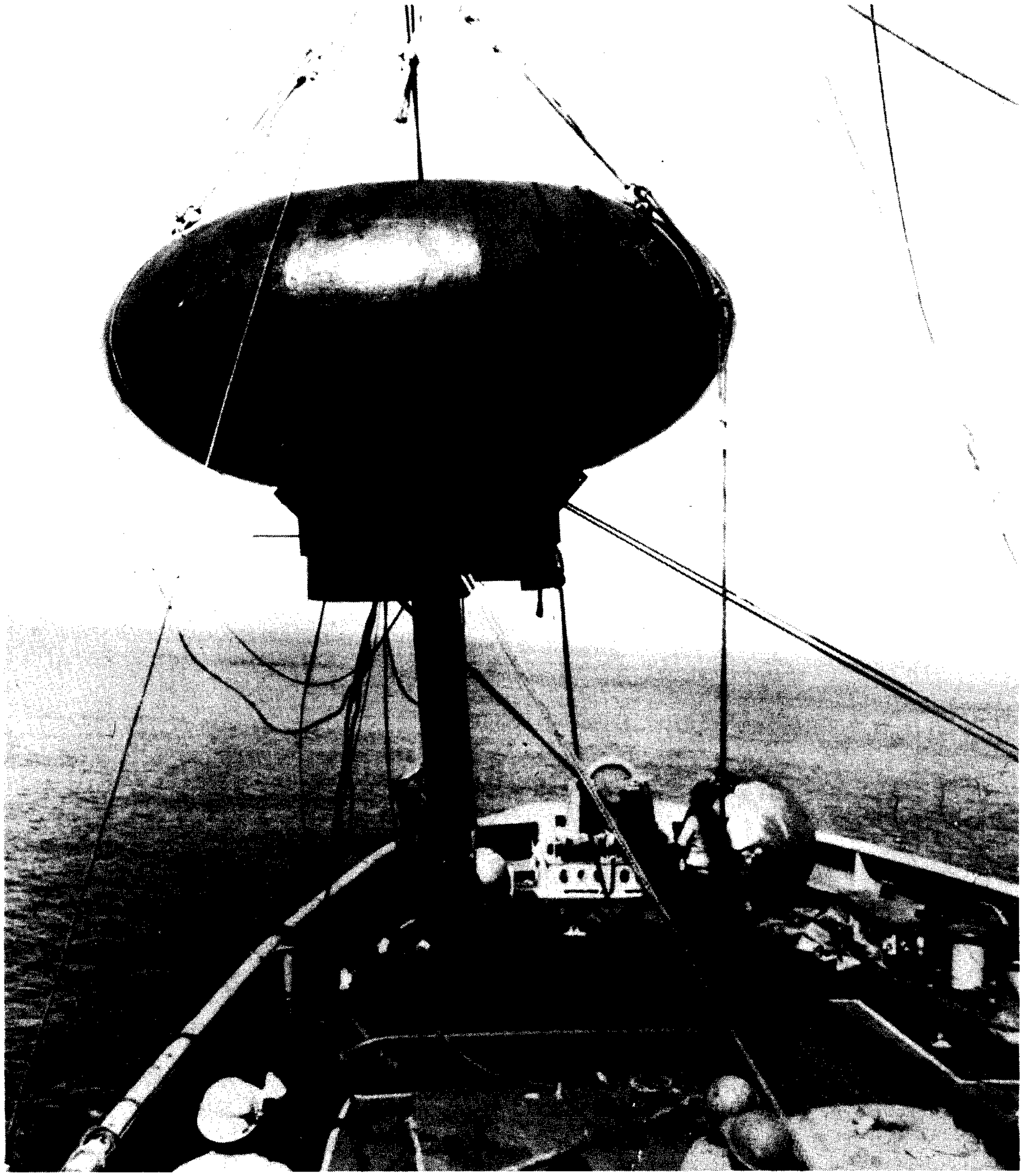
Purpose of AFAR range is to obtain scientific and ocean engineering information concerning acoustic parameters in the ocean environment.

LAYOUT OF AZORES FIXED ACOUSTICAL RANGE (AFAR)



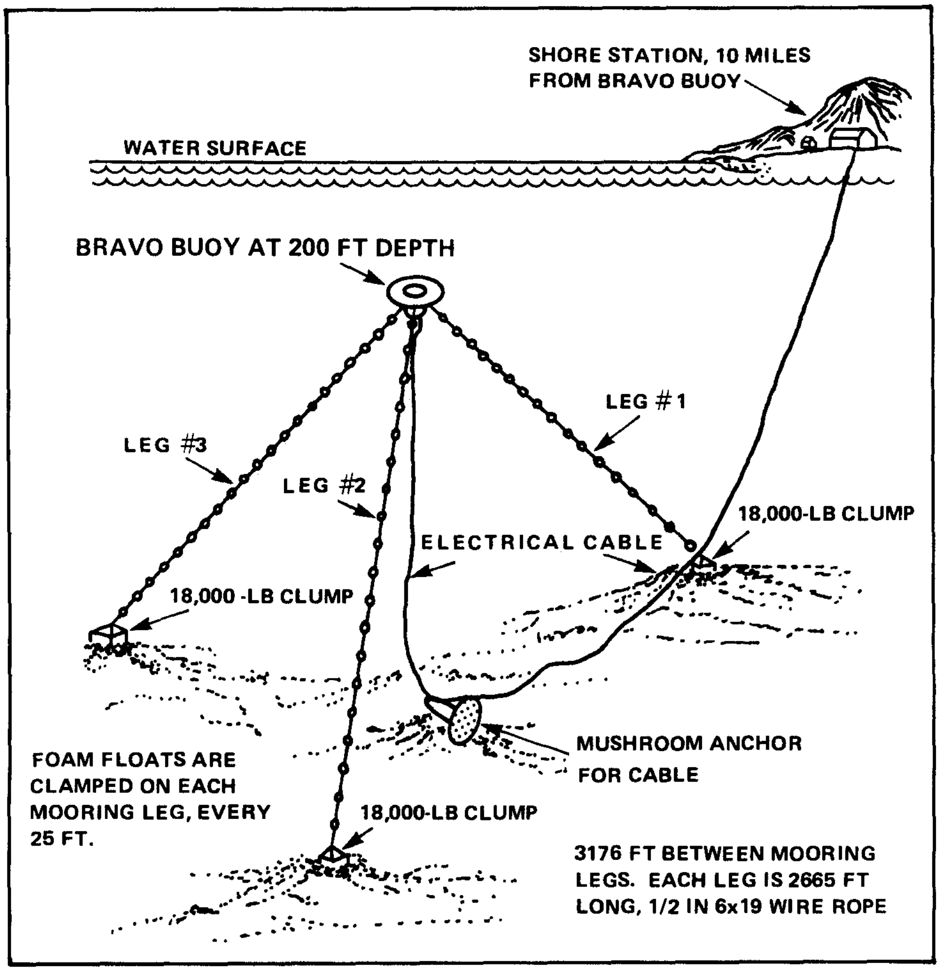
ECHO, the easternmost of three 120-foot-high towers, had to be lifted off the sea bottom by means of a lifting eye at its top, and turned approximately 95°, to a new orientation.

ECHO ACOUSTIC-ARRAY TOWER



BRAVO oceanographic buoy for underwater environmental measurements is 13 feet in diameter and weighs 5,000 pounds in the air.

BRAVO UNDERWATER ENVIRONMENTAL MONITORING BUOY



BRAVO Buoy, under 12,000 pounds positive buoyancy, is maintained in submerged position, 200 feet below surface, by three mooring legs. Water depth is 2,080 feet.

BRAVO BUOY'S UNDERWATER POSITION

Underwater Systems Center (NUSC), New London, Connecticut. The buoy – with an electronics package attached – was designed to be moored 200 feet below the surface in 2,200-2,300 feet of water, in a 3-point moor using 18,000-pound cast iron anchors.

Cables to Shore Stations

A laboratory built on the island of Santa Maria serves as a shore monitoring station. This station is connected to the towers and the buoy by underwater cables. A Naval

Construction Unit of the U.S. Atlantic Fleet, with the help of a NUSC laboratory team, outfitted the shore laboratory, installed the overland cable runs, and implanted the surf cables. Three different sets of cable are used in the Azores range: buoy cables, transmitter cables, and receiver cables. The transmitter and receiver cables were built in the United Kingdom, and the buoy cable was supplied by the United States. These cables connect the towers and the buoy to the laboratory on Santa Maria Island.

THE 1973 OPERATIONS REQUIREMENTS

The Director of Ocean Engineering, U.S. Navy, Naval Sea Systems Command (then Naval Ship Systems Command), was tasked by the Naval Underwater Systems Center, New London, to conduct operations during the summer of 1973 in support of the Azores Fixed Acoustic Range.

The northern receiving tower of AFAR, NOVEMBER, had suffered a casualty in its training mechanism and was approximately 95 degrees out of horizontal alignment with the ECHO Tower. The first task was to locate the NOVEMBER Tower, attach to it, and lift it off the bottom. After rotating it approximately 93 degrees to line up with the ECHO Tower, it would then be set back on the bottom.

A second task was to recover Buoy BRAVO, the large subsurface environmental buoy which measures ambient noise and wave height. The buoy system had been inoperative since initial implantment in 1972. Since BRAVO is subsurface moored at a depth of 200 feet, it was required to locate the 18,000 pound clump anchor on one of the three legs, and to lift it clear of the bottom. It would then be moved toward the center of the moor, thus slackening all legs of the moor. This would allow BRAVO to rise to the surface where it could be repaired.

The third task was to make ready a NOMAD Buoy with a thermistor string and to implant the buoy in the range. The NOMAD was needed to measure water temperature, air pressure and temperature, wind velocity, and other readings to be transmitted to the laboratory ashore on Santa Maria Island.

The fourth task consisted of using an acoustic device to calibrate the three underwater towers, the BRAVO Buoy, and the acoustic tracking range that is located between the towers.

PLANNING AND PREPARATION

Organization

The Director of Ocean Engineering appointed his representative as on-site Operations Director for this operation. The Director of AFAR from Naval Underwater Sound Laboratory (NUSC), provided on-scene technical assistance. NUSC provided a test director who also was coordinator for the assembly of all the government-furnished equipment required for the four tasks. Ocean Search, Inc. was selected as the contractor to provide the required ocean engineering assistance. Ocean Search's vessel, ALCOA SEAPROBE, was used to transport all equipment to the site, and perform the necessary operations. Ocean Search's director of ALCOA SEAPROBE operations was directed by the SUPSALV representative, who was in overall charge of the at-sea work.

Preliminary Activity

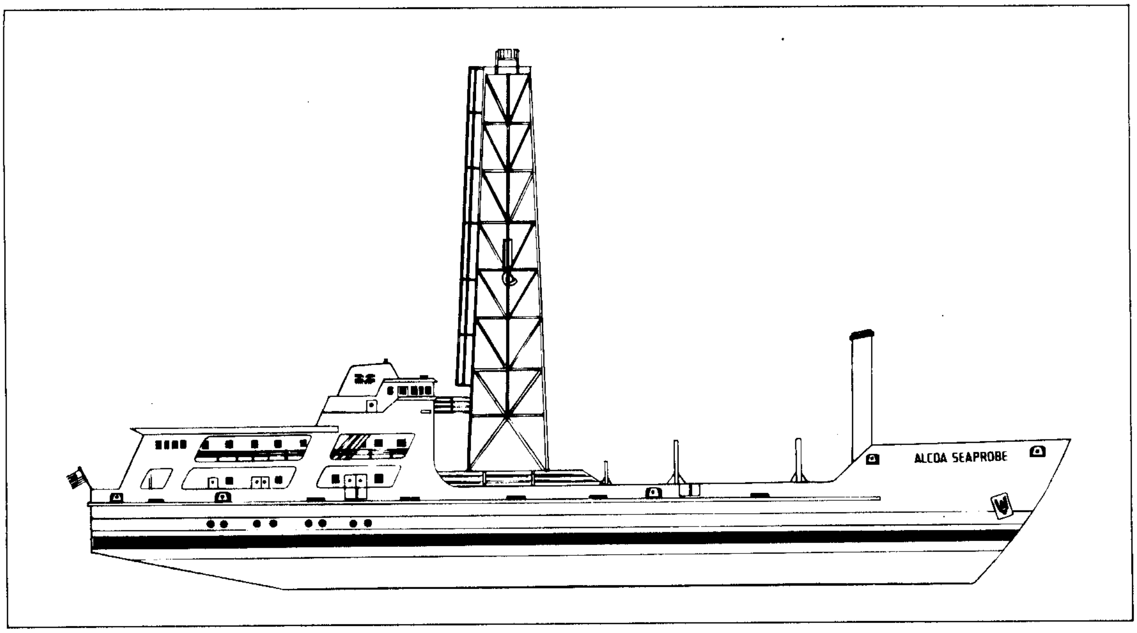
The tasks assigned involved the solution of several difficult ocean engineering problems. It was decided that after the pre-engineering had been accomplished, and specially designed hardware delivered, at-sea tests in the vicinity of the Bahama Islands would be conducted. This was needed both for crew training and to ensure the operational suitability of the concepts and equipment furnished. After successfully completing the evaluation and training operations, the ALCOA SEAPROBE returned to Port Everglades, Florida. There approximately 35 tons of equipment required for the operations was loaded, and the expedition departed for the Azores.

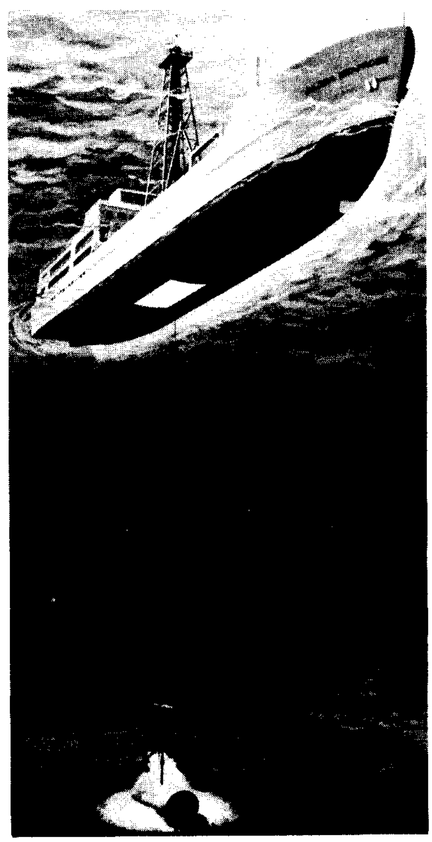
ALCOA SEAPROBE

General

The R/V (Research Vessel) ALCOA SEAPROBE is a 243-foot all-aluminum research vessel designed for oceanological exploration and a variety of underwater work, using advanced new systems and working capacities. The ALCOA SEAPROBE is sufficiently unique to merit tabulating some of its basic characteristics.

Length	243 feet
Beam	50 feet
Draft	14 feet (propeller depth)





ALCOA SEAPROBE is a highly specialized underwater work ship. It is uniquely equipped for underwater search, identification, and salvage. The marine application of an oil-drill pipe-string as the core of sonar, manipulator, and closed-circuit TV system, has proved to be a flexible and effective tool for a variety of deep ocean applications.

ALCOA SEAPROBE WAS THE BASIC ELEMENT IN THE 1973 SUPPORT OPERATIONS FOR AFAR

Basic Characteristics (Continued)

Displacement	1,700 tons
Speed	10 knots
Range	6,600 miles
Endurance	45 days
Main Power	Two 800 KW diesel-electric generators
Auxiliary Power	Two 250 KW diesel-electric generators
Propulsion	Two Voith-Schneider Cycloidal omni-directional propulsion units
Auxiliary Deck Equipment	Two 5-ton cranes Oceanographic winch – interchangeable drums
Ship Control	Decca ship control consoles on bridge and in search/recovery control center
Primary Ship Construction Material	5456-H117 aluminum plate 5456-H111 aluminum extrusions

ALCOA SEAPROBE is a dynamically-positioned working platform. The ship can be very accurately navigated for precise area-searches and can hold an exact position in the open ocean against winds and currents with the aid of the following systems:

- ocean-bottom-mounted acoustic reference systems;
- land based, precision short-range and medium-range radio locating systems;
- radar positioning relative to land-based or moored reference points;
- worldwide positioning systems employing satellites and/or VLF Omega;
- two Voith-Schneider cycloidal omni-directional propulsion units.

Capabilities envisioned include the ability to recover 200-ton payloads from 6,000 feet below the surface of the water, and to search, core, drill, and sample mineral deposits in water depths to 18,000 feet.

Deep Ocean Capabilities

The working end of the ALCOA SEAPROBE system is located at the end of a pipe string made of 60-foot segments of aluminum drill pipe threaded together to reach the ocean depths required.

Using the semi-rigid pipe system, ALCOA SEAPROBE deploys a search, identification, and sensor package in close proximity to the ocean floor. This system is designed to permit accurate control of the sensor package, relative to the ship's working platform, and with regard to the sea floor or objects on the floor.

Depending upon the task at hand, sensor systems are deployed for fine-grain bottom search and examination, target identification and marking, or oceanographic sampling and measurement. Recovery devices, ranging from multi-purpose grappling claws to coring tools, are available for lifting bottom objects or cores to the surface. A cable affixed to the exterior of the pipe provides the necessary electrical power, telemetry control signals, and data transmission circuits between the shipboard control consoles and the sensor systems probing the deep ocean. All these components are directed by remote control from an operating center aboard the ALCOA SEAPROBE.

Underwater Search and Inspection

A thruster system at the working end of the pipe provides precision control and positioning of sensor packages, recovery mechanisms, viewing or recording systems, and television for real-time examination of deep ocean objects. The basic search "pod" deploys side-scan sonar to sweep a 2,400-foot path along the sea floor. The pod is configured with forward-looking sonar, television, still camera, target illumination systems, and a droppable acoustic beacon to use in marking specific target locations. Additional sensors, detectors and other special devices may be added to the pod to meet the requirements of specific missions.

Under Sea Recovery

Using sonar and television for target location and identification, ALCOA SEAPROBE is also designed to be capable of selectively lifting multi-ton weights from the sea floor. This lift capacity is made possible by the tensile strength of 4-1/2 inch diameter drill pipe. The drillstring system is dependent on the capabilities of the seagoing oil derrick centrally mounted on the ALCOA SEAPROBE's main deck.

Derrick	Height:	132 feet (above waterline)
	Capacity:	250-ton hook load with safety factor of 2
	Material:	6061-T6 aluminum tubing 5456-H321 aluminum plate
Drawworks	EMSCO 800 with 600 HP motor generator power supply for DC control	
Pipe	4-1/2" external upset-internal flush Sections 60 feet in length	

A variety of heavy object recovery devices can be attached to the end of the pipe string and can utilize either electro-mechanical or hydraulic systems for closure and holding control. Precise positioning of the recovery device with respect to the target is effected by sonar and transponder sensing devices, in concert with remotely monitored television and target illumination systems.

This equipment, as well as the delivery and positioning capability of the ALCOA SEAPROBE, was crucial to the success of the 1973 operations on AFAR.

OPERATIONS

En Route

After ALCOA SEAPROBE departed Fort Lauderdale, she sailed directly to Ponta Delgada on San Miguel Island, Azores, arriving there on 8 July. The next two days were spent preparing the equipment and offloading designated equipment to be placed in the laboratory.

The ALCOA SEAPROBE departed Ponta Delgada Wednesday afternoon, 11 July, for the assigned at-sea operations. Approximately one day was needed for range calibration.

First Task: Reorienting NOVEMBER Acoustic Tower

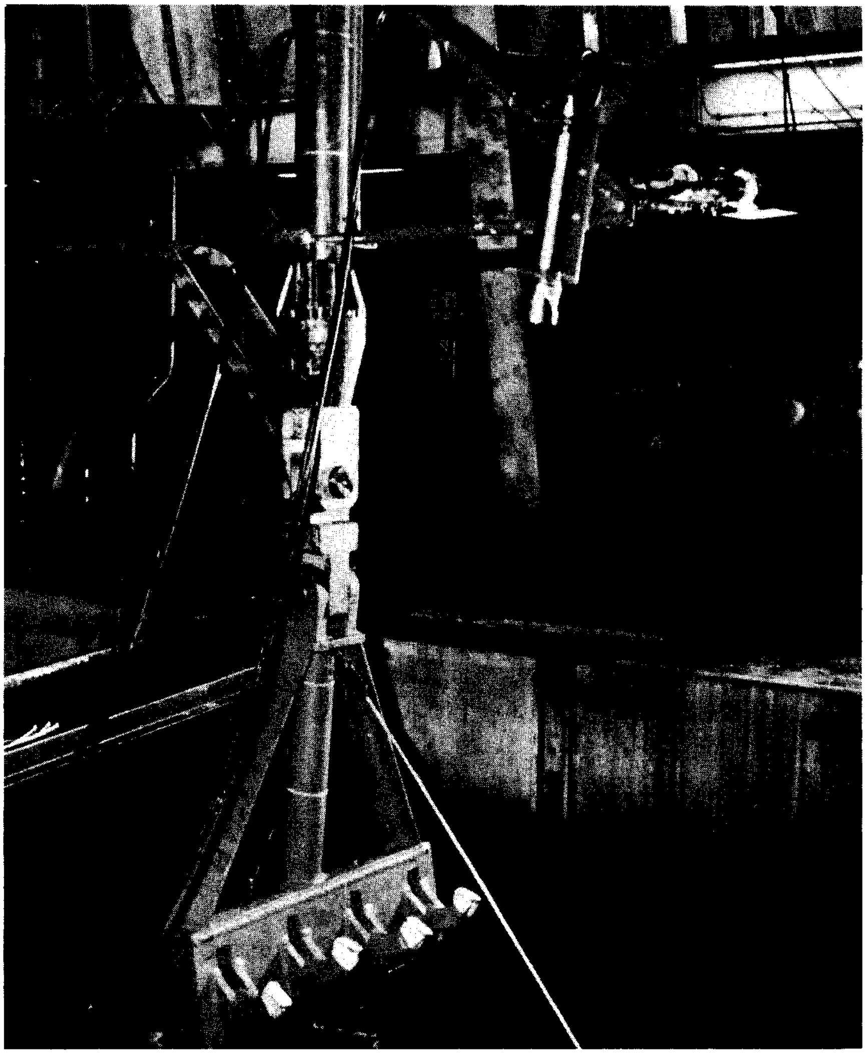
NOVEMBER Tower required reorientation to align its antenna axis with the ECHO Tower. The ALCOA SEAPROBE was fitted with special equipment and all operations were

One of ALCOA SEAPROBE's remote systems, operating close to the sea bottom, is controlled from the operating center and monitored on a graphic plotter. Sonar and closed-circuit TV screens are on the back edge of the control table.

UNDERWATER SYSTEMS CONTROL AND MONITORING EQUIPMENT ABOARD ALCOA SEAPROBE

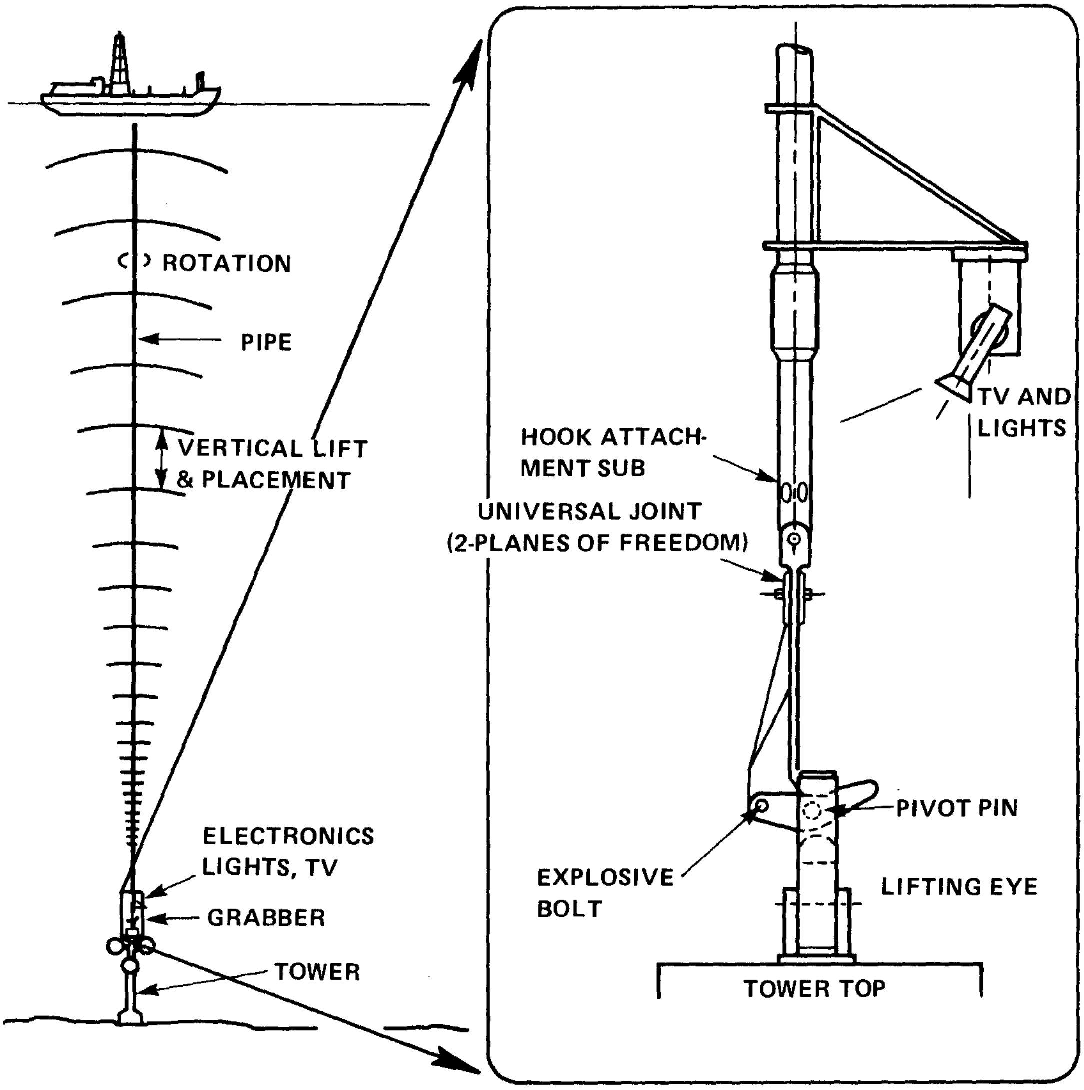
concentrated and controlled from the ALCOA SEAPROBE's operations center. A special precision Motorola Mini-Ranger navigation system, installed on the Islands of Santa Maria and San Miquel, was used for positioning.

The NOVEMBER Tower weighed 70 tons in air but inherent buoyancy reduced its weight to about 8,000 pounds in water. For the pickup and rotation of this tower, a special hook device for the drill-string was designed and fabricated with individual explosive hook releases. This hook was designed to fit through the six-inch padeye on the top of the tower with a snug fit, so that when the tower was rotated no lost motion would be encountered.



The special hook array, fabricated for the drill-pipe string, is shown in position over the center well in ALCOA SEAPROBE's bottom. It was designed for a snug fit in NOVEMBER Tower's padeye to reduce lost motion in turning the tower.

ALCOA SEAPROBE's MULTIPLE-HOOK ARRAY USED TO REORIENT NOVEMBER TOWER



To lift and reorient NOVEMBER Tower, ALCOA SEAPROBE had to thread its hook through a padeye and twist its drill-pipe string 93°. Control of the operation from ALCOA SEAPROBE was greatly facilitated by the closed-circuit TV on the working rig.

HOOKING NOVEMBER TOWER FOR REORIENTATION

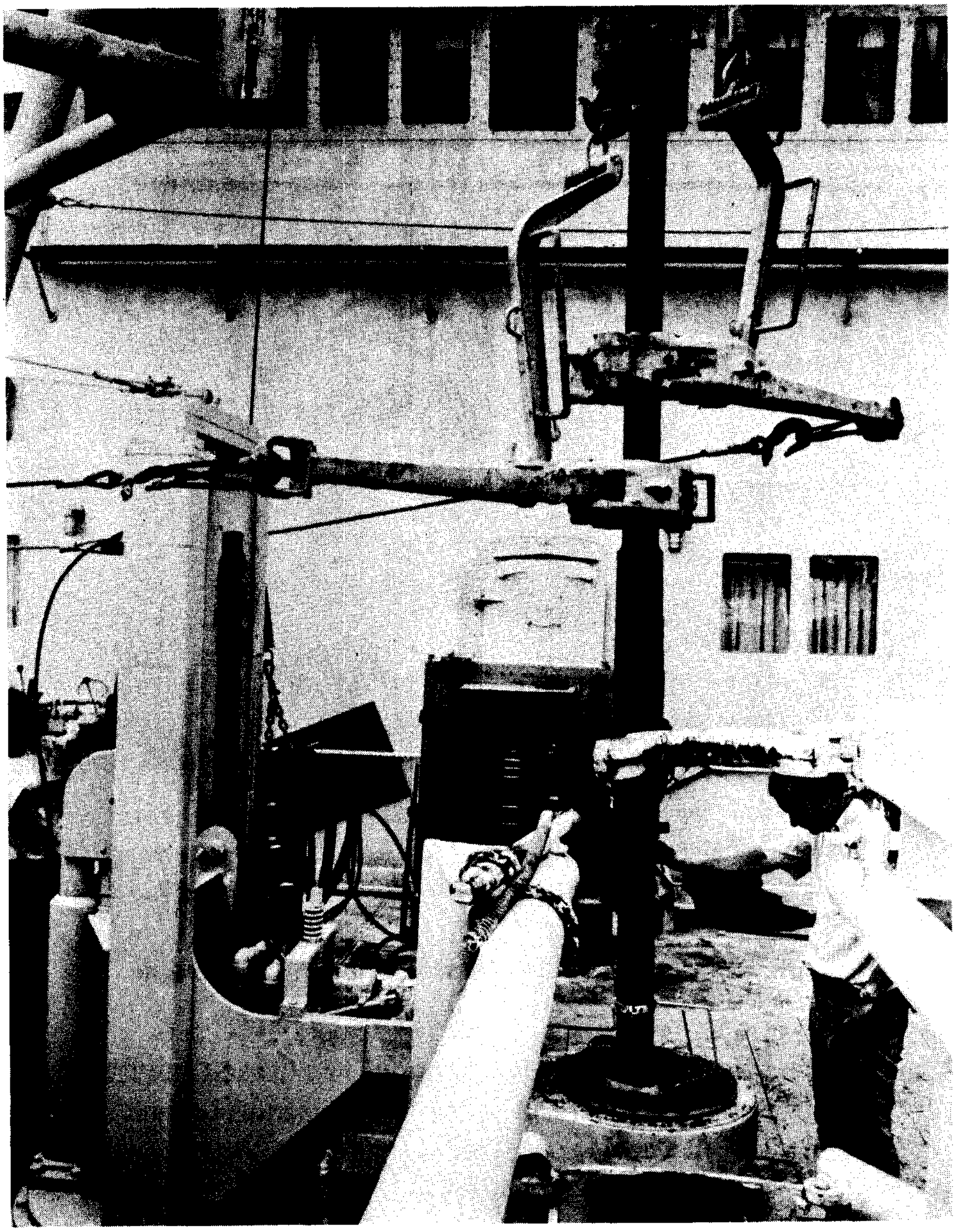
ALCOA SEAPROBE was to fly the special hook at the end of the drillpipe string into the six-inch padeye, lift the tower, and rotate it to the desired position. The acoustic ship positioning system built into the ALCOA SEAPROBE was used as the primary navigation system. Two acoustic navigation pingers were prepositioned on the ocean floor adjacent to the tower to facilitate quick location.

The pickup went as scheduled. However, it was found that under the 10- to 14-foot swell conditions, the explosive bolts of the hooking assembly sheared during extremely heavy oscillations, allowing the hook to fall open. The tower then fell back to the ocean floor. It was determined that, if maximum swell conditions alleviated, the hook and release would perform as designed. The tower was picked up six times and relocated back on the ocean floor during this rotation period. Griphoist "come-alongs" were used to rotate the drill-string up at the ship's end. However, it was found that the large shore connection cable attached to the bottom of the tower prevented the tower from freely rotating. The ship, with the tower attached to the drill-string, was maneuvered so the cable was overtwisted and exerted a neutralizing torque in the proper direction, and the tower was properly reoriented. After orientation, a final calibration determined that the tower was within 2 1/2 degrees of its optimum axis.

Second Task: Retrieval and Repair of BRAVO Buoy

For the pickup of BRAVO's 18,000-pound anchor, techniques similar to those used for the NOVEMBER Tower pickup were employed. The hooks used for the tower pickup were replaced with longer finger hooks. Previously, a special finger-type grabber had been designed and tested to be used in pickup of the clump anchor. It was determined during the pre-AFAR tests that the finger-type grabber was of too light construction to be used on the large anchor clump and the possibility of malfunction was considered to be high. Therefore, the finger-type grabber concept was held in reserve in favor of the pickup hook previously described.

The anchor clump had approximately 3,500 feet of 1-3/8" crown wire attached and laid out in a westerly direction. This was picked up by the ALCOA SEAPROBE by monitoring the position of the hook rig with the closed-circuit TV system. Positioning was maintained with ALCOA SEAPROBE's precision maneuvering system. The drill-string was deployed with the finger-hook rig attached, and after the crown wire was located, it was followed along the ocean bottom to the anchor location. The anchor was found to be on its side, with the lifting bail parallel to the ocean floor. This condition prevented the use of the pickup hook as planned. (With the anchor on its side, the hook could not be engaged in the bail without possible damage to the attached cable from the buoy.) Therefore, it was decided that the pickup hook would be used to grapple for and ensnare the attached crown wire laid out from the anchor across the sea floor. This was accomplished with a knot tied in the crown wire used for the actual pickup and relocation of the anchor clump. After the pickup hook was engaged in the crown wire, the hook was brought into the well in the bottom of the ALCOA SEAPROBE. Here, carpenter stoppers were attached to the crown



Reorienting NOVEMBER Tower the desired 93°, involved twisting ALCOA SEAPOROBE's drill-string through this arc. This was accomplished by means of the grip hoist "come-alongs" shown above.

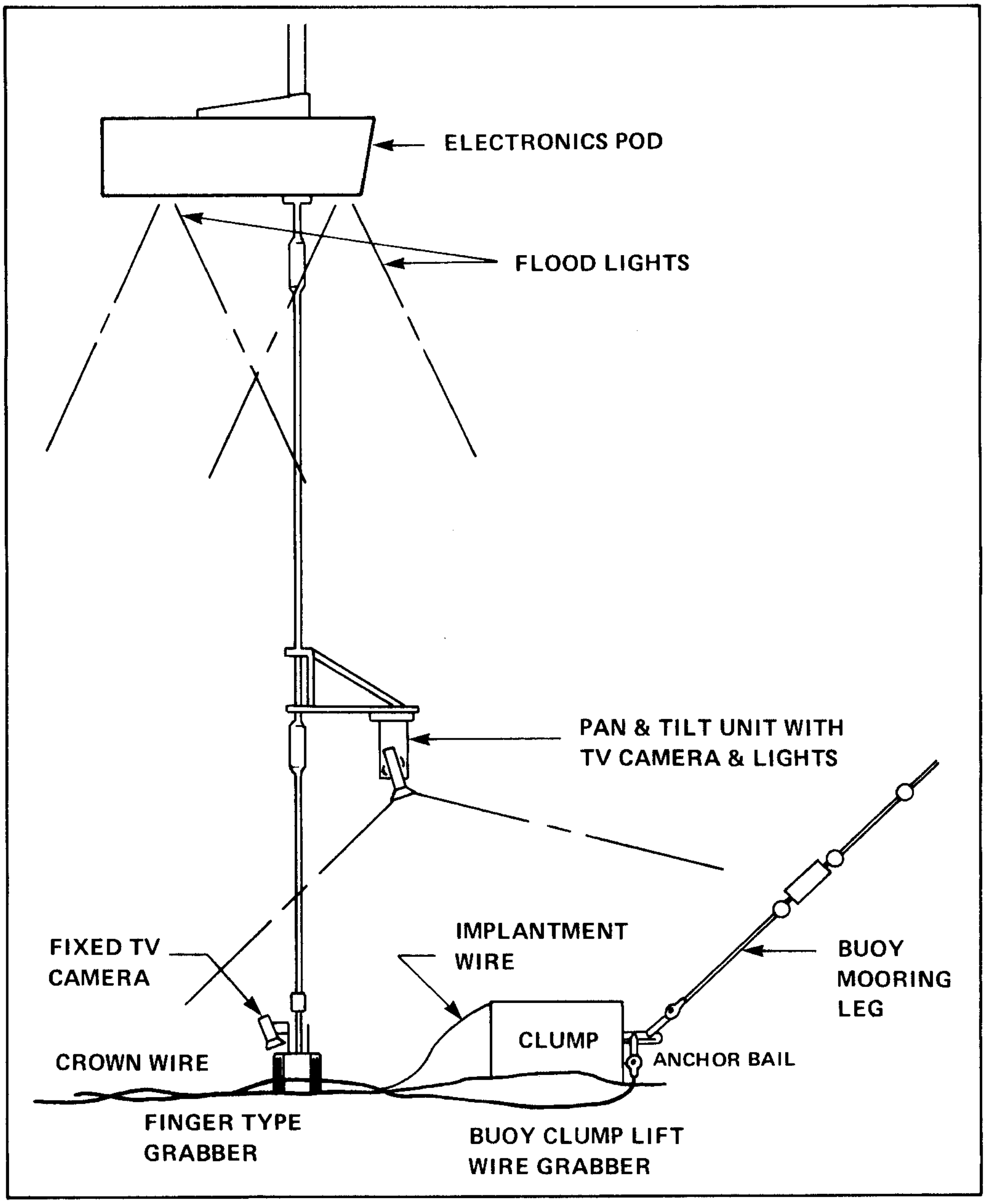
METHOD FOR TURNING THE HOOKED TOWER

A hook array for the drill-pipe string was fabricated which had longer finger-hooks. It was used, as shown above, to hook the crown wire of BRAVO Buoy's anchor and pull it aboard to subsequently lift and move the anchor.

HOOK ARRAY USED TO CAPTURE BRAVO BUOY'S ANCHOR

wire, and the bitter end of the crown wire hauled into the ALCOA SEAPROBE's well. After surfacing the BRAVO Buoy, the bitter end of the crown wire was brought outboard of the ALCOA SEAPROBE and attached to an 8.4-ton pontoon buoy. The anchor was then released, somewhat inside its proper leg position.

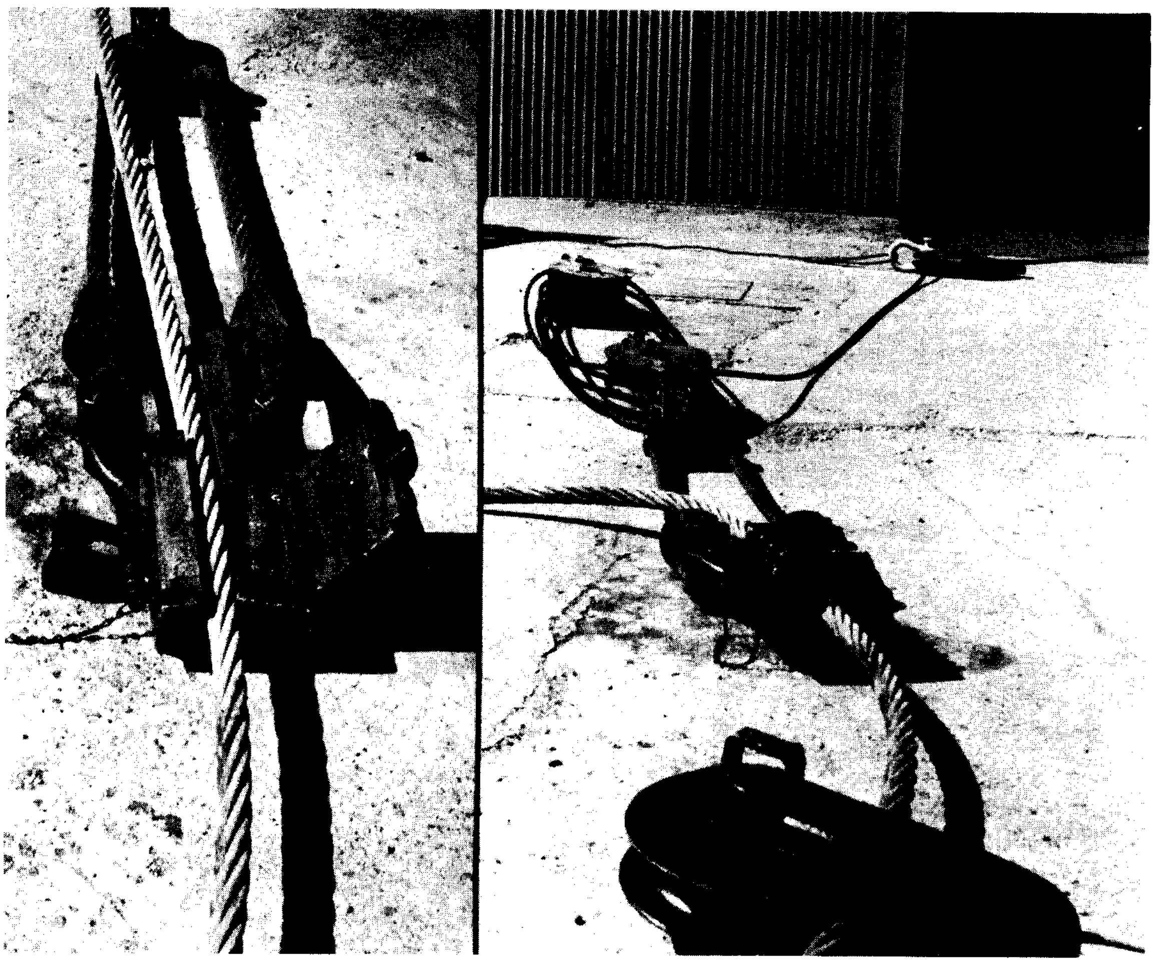
When the buoy was brought to the surface for inspection and repair, inspection revealed that the complete hydrophone assembly and the wave height-measuring transducer both required replacement. However, the electronic package was functioning properly. The ALCOA SEAPROBE stayed positioned alongside the BRAVO Buoy, providing a lee for two Zodiac pneumatic rubber workboats, out of which the diver and electronics teams worked. Various electronic components, transducers, and the hydrophone assembly were replaced. The BRAVO Buoy was then returned to a depth of approximately 184 feet by the ALCOA



The ALCOA SEAPROBE's closed-circuit TV system was used to locate the crown wire of BRAVO Buoy's anchor. This was necessary because the position of the anchor bail prevented direct lifting. The anchor was then moved by means of the crown wire.

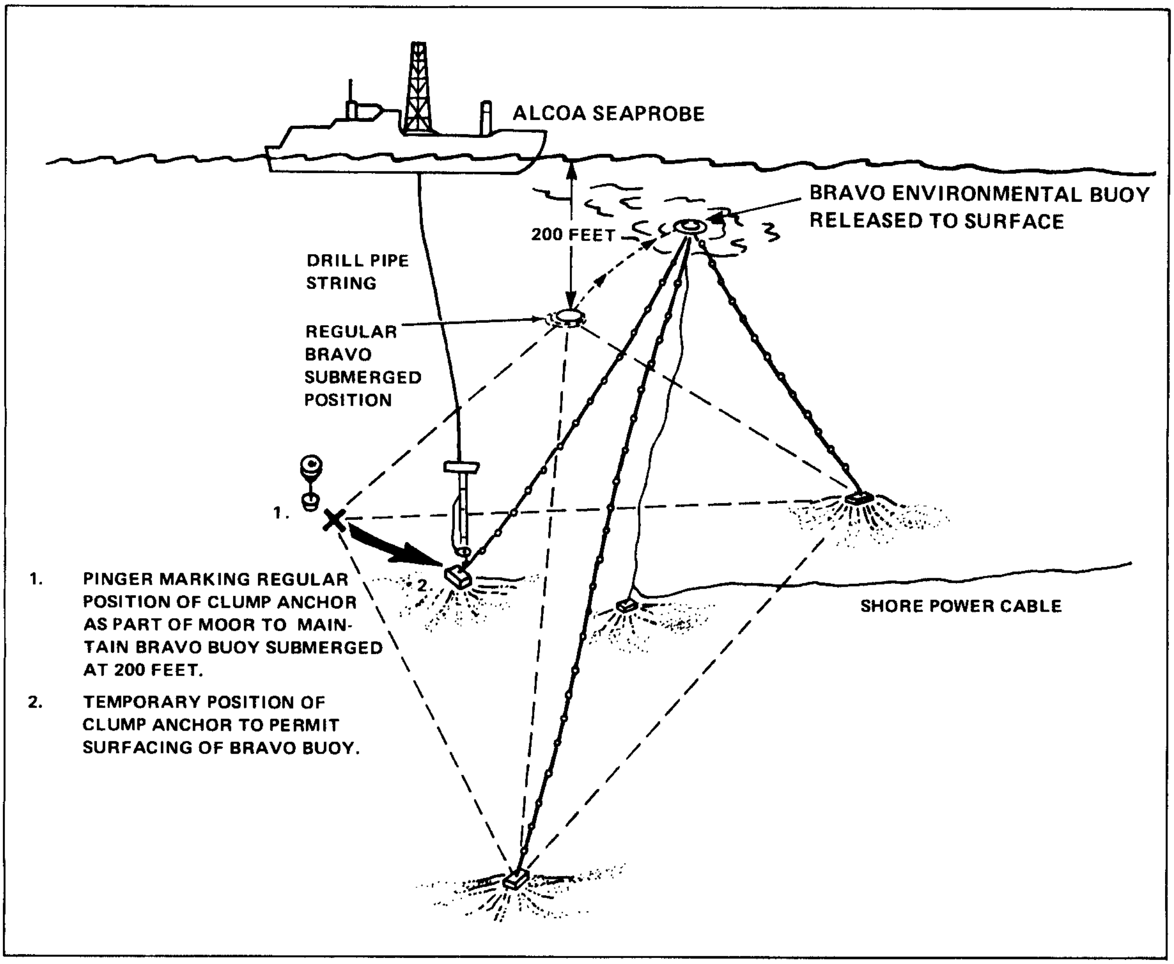
METHOD OF HOOK CROWN WIRE TO MOVE BUOY ANCHOR

SEAPROBE hauling on the crown line to drag the anchor clump out to its leg position. A second 8.4-ton pontoon buoy had been attached to the BRAVO as a surge buoy to indicate its arrival at a depth of 200 feet. The BRAVO Buoy was successfully reimplanted and reported to be functioning properly.



To permit a full strain to be taken on the crown wire of BRAVO Buoy's anchor, carpenter stoppers – a standard item of salvage equipment – were used. One is shown in the open position on the left, and in the closed grip position, on the right.

CARPENTER STOPPERS WERE USED TO HAUL CROWN WIRE

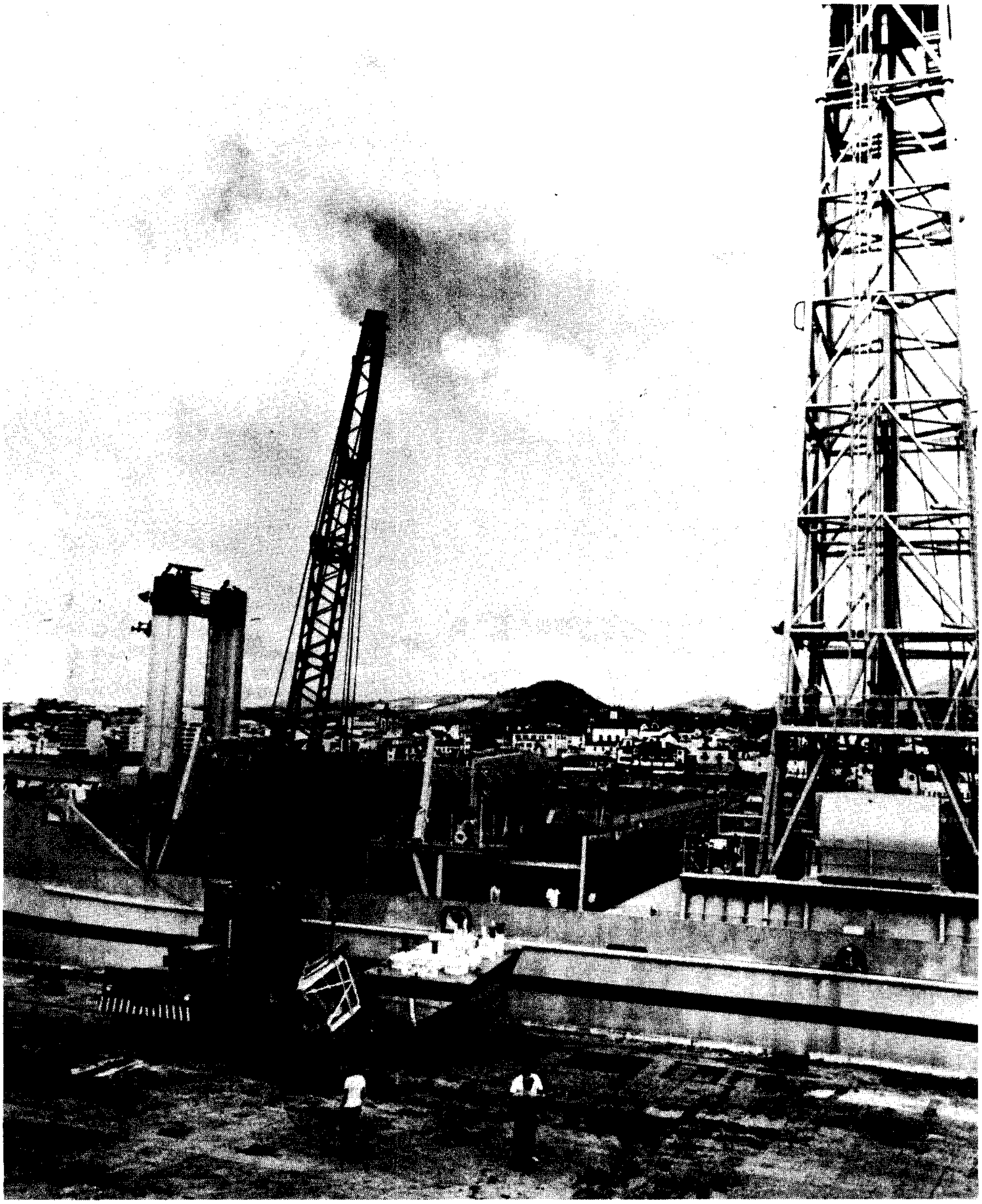


One of the anchors in BRAVO Buoy's moor was moved to a mid-position between the other two legs. Once allowed to assume a vertical direction, the length of the released leg was sufficient to bring BRAVO Buoy to the surface.

MOVING AN ANCHOR TO BRING BRAVO BUOY TO THE SURFACE

Third Task: Installing the NOMAD Buoy

The third phase was the installation of the NOMAD Buoy with a 700-foot thermistor string. In this operation, the 1,600-pound clump anchor was assembled aft and hung over the stern of the ALCOA SEAPROBE. An LCM, with the NOMAD Buoy alongside, brought the buoy to the starboard side of the ALCOA SEAPROBE. The thermistor string and tether



The final element in operations was to add a weather buoy to the AFAR system. It is shown at pier side. Its installation included a deployed thermistor string.

NOMAD BUOY FOR AFAR

line were taken aboard the ALCOA SEAPROBE from the LCM by ship's crane and laid out on deck. The LCM was then used to haul the NOMAD Buoy clear while the 700-foot thermistor string and 3,000-foot nylon anchor line was played out from amidships of ALCOA SEAPROBE. The entire anchor system was then burdened off to the anchor, ready for deployment. The buoy was towed into position, and the anchor released using the "anchor last" method. The deployment was successful, with the thermistor string working properly after deployment.

CONCLUSIONS

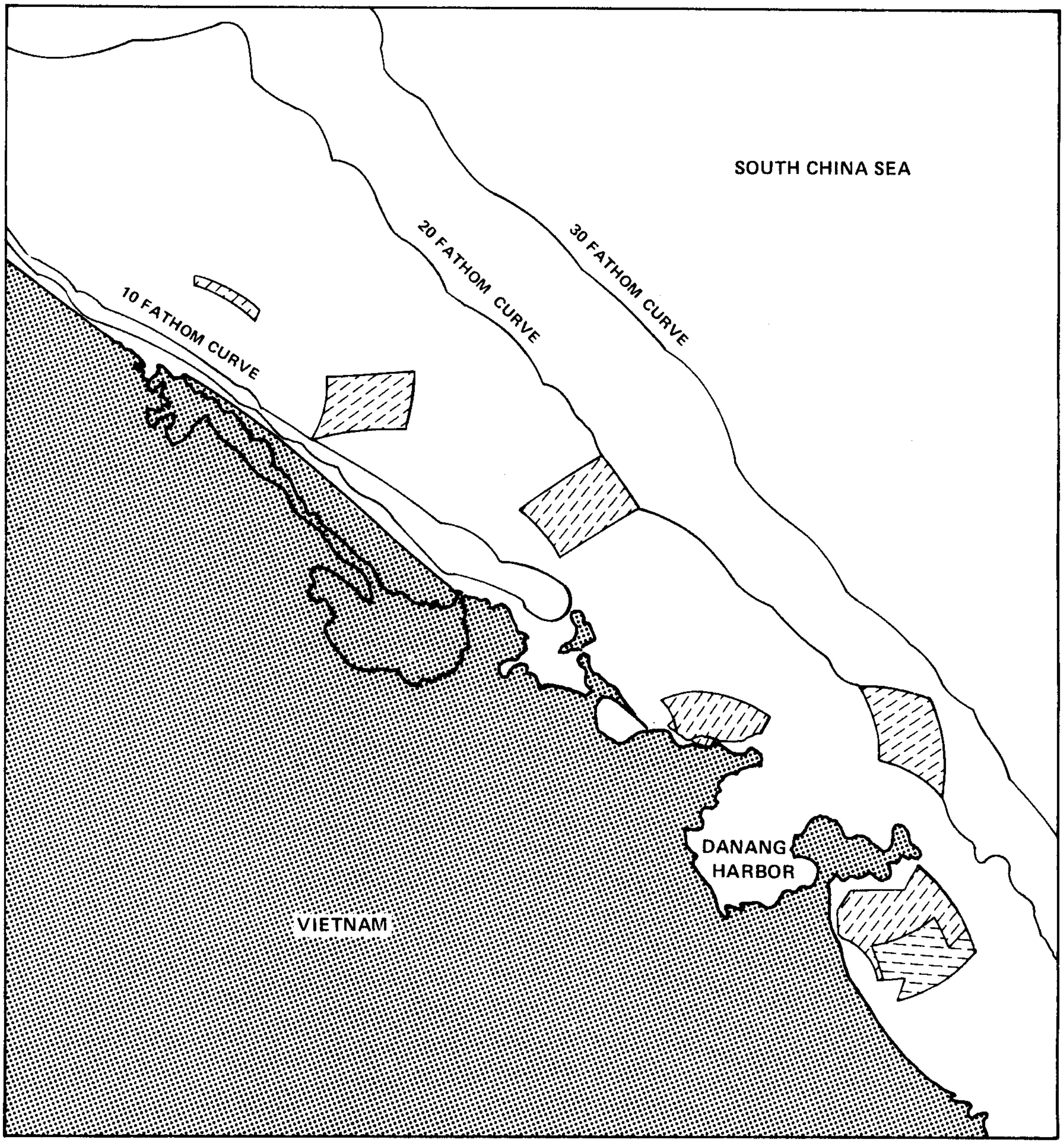
The support provided for AFAR during the 1973 working season constitutes a good example of the effectiveness of the Navy's deep engineering capabilities.

Both from within the Navy itself and from the technical organizations under contract to the Office of the Supervisor of Salvage, the most advanced underwater technology today is available.

The careful planning and preparation, such as the rehearsal operations carried out by the ALCOA SEAPROBE team, are an essential part of the developing technology. In each of these support commitments, new techniques are being evolved to meet the continually expanding requirements of the Navy to utilize and further exploit the sea environment. For the acoustic tower reorientation phase of operations, the lift capability of ALCOA SEAPROBE was tailored to the special demands of the work. When an unforeseeable complication with a fouled underwater cable produced a special problem, a method of coping was quickly found.

Difficulties in recovering underwater BRAVO Buoy were anticipated. Equipment tailored for the job provided a back-up technique, in permitting capture of an anchor crown wire. Again SEAPROBE's drill-pipe-string-mounted array provided a capability to readily accomplish what might have proved an impossible task without it. This evolution, in general, shows a commendable (if expected) level of equipment seamanship. The efficient handling of cables, anchors, stoppers, hoists, etc., and the effective employment of divers and work craft demonstrated application of skills developed for salvage work which may be applied with equal effectiveness to non-salvage requirements of the Navy.

SUPPORT OPERATIONS FOR THE JOINT CASUALTY RESOLUTION CENTER (JCRC), SOUTHEAST ASIA



Seven coastal water areas of the South China Sea were designated for search of wrecked aircraft in order to gather data that would resolve the status of men missing in action (MIA) in Southeast Asia. Search and recovery operations under the supervision of SUPSALV, were conducted for this purpose.

OFFSHORE AREAS SEARCHED FOR JCRC

SUPPORT OPERATIONS FOR THE JOINT CASUALTY RESOLUTION CENTER (JCRC), SOUTHEAST ASIA

With the phaseout of U.S. involvement in Southeast Asia, and the return of U.S. prisoners of war, the problem arose of establishing the fate of numerous men who were listed as missing in action (MIA), whose disposition could not be ascertained. To resolve as many of these cases as possible, the Joint Casualty Resolution Center (JCRC) was established. A number of these personnel were lost in aircraft accidents off the coast of South Vietnam. Because of the marine salvage expertise and resources required, the Supervisor of Salvage (SUPSALV) was tasked with the responsibility for the necessary search and recovery operations.

Preparations were begun in early June 1973. First, arrangements for a precision navigation system, sonar, divers and the search and recovery platform had to be completed. Actual search operations began on the 10th of July and continued for the next 82 days. During that time, 77 square miles of ocean bottom were systematically and carefully searched. The search and recovery team was able to obtain 36 positive contacts, 14 of which were aircraft related. Two of these, including one that resulted in the reclassification of missing personnel, were of interest to the JCRC.

BACKGROUND

Mission

During the extended U.S. combat operations in Southeast Asia, many military personnel were lost under circumstances that prevented a positive determination of their loss. The establishment of a cease fire provided the non-combat environment needed to establish their fate. To resolve as many of these cases as possible the JCRC was established. It had the specified mission to: "assist in resolving the status of United States personnel missing in action (MIA) or killed in action, bodies not recovered (KIA/BNR), throughout Southeast Asia."

JCRC Organization

The JCRC, headquartered at the U.S./Thai air base at Nakhon Phanom, Thailand, was organized into two functional sections – a staff element and a field element. The staff element, in addition to providing normal staff support, maintained two other sections. One maintained all available data on MIA and KIA/BNR cases and the other handled the necessary public relations in countries visited by search teams. The field element consisted primarily of two control teams, Alpha and Bravo. Team Alpha was responsible for command functions and field operations in Vietnam, while team Bravo was responsible for field operations in Laos and Cambodia. At-Sea Operations were planned and managed by the Supervisor of Salvage (SUPSALV), U.S. Navy, under the operational command of Commander, 7th Fleet, and were responsive to Commander, Joint Casualty Resolution Center.

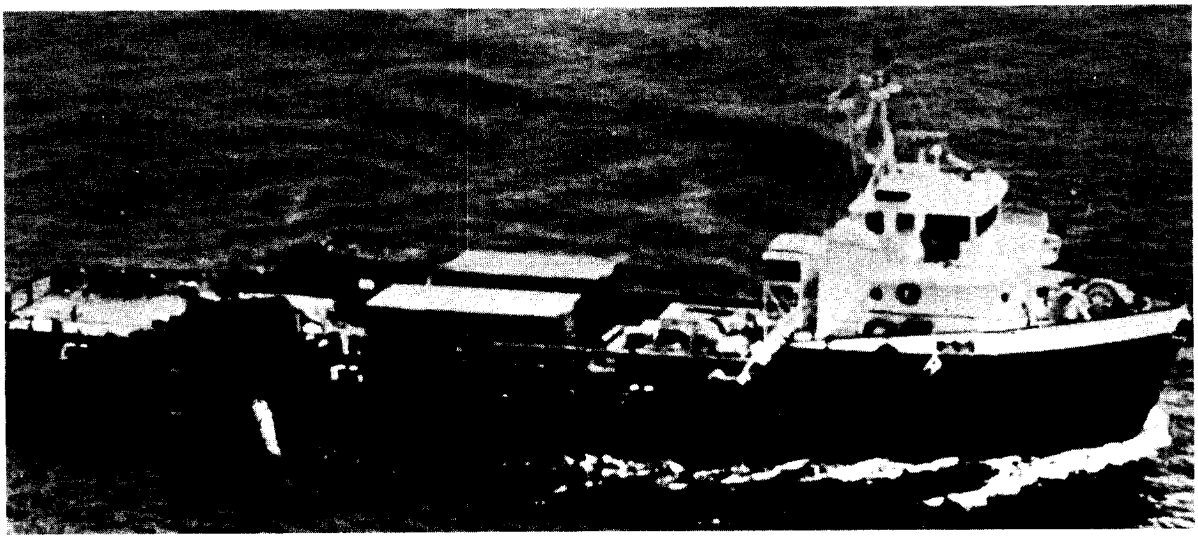
Mobilization of the At-Sea Search and Recovery Team

When tasked with the operation in mid-June, SUPSALV immediately began preparations. Seaward, Incorporated was contracted to provide the required search equipment and personnel, including a Project Manager. On the 19th of June, a SUPSALV Representative and the Project Manager met with the JCRC Representative in Saigon, Vietnam. The following week, travel arrangements and visas were procured for the other personnel, and Military Airlift Command (MAC) flights were set up to transport necessary equipment from the United States.

On 26 June, the Project Manager traveled to Singapore, where arrangements could be made for a vessel to serve as the surface support platform. Craft that adequately fulfilled the necessary requirements were in short supply, but a suitable offshore supply vessel, the M/V SEA TENDER, was located. Contract arrangements with the owner were finalized on the 29th; stores, food, and other required equipment were placed aboard; and the ship departed for Vietnam on the 3rd of July.

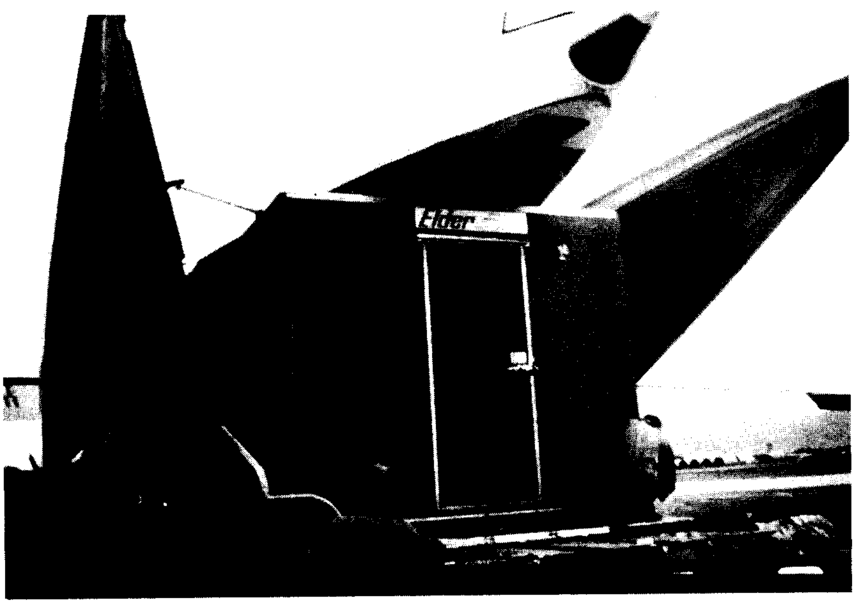
At Danang, in Vietnam, preparations and coordination continued in order to commence operations on 10 July. A minor delay arose on 7 July when the MAC aircraft bringing the personnel and equipment from CONUS accidently violated the Saigon restricted air space, and search team personnel and equipment were temporarily detained by immigration officials. However, this was resolved quickly the following day and the men and equipment proceeded to Danang.

The SEA TENDER arrived in Danang on the 8th of July and the loading of equipment was begun. Here, also, there was some delay of the equipment trucks at the airfield by Vietnamese Army personnel; but final loading and testing of equipment was completed, and all personnel and equipment were ready to commence operations by 10 July.



This typical offshore petroleum industry support vessel was chartered in Singapore for use by the SUPSALV managed team that conducted search, diving and recovery operations in support of the Joint Casualty Resolution Center (JCRC) in Southeast Asia.

M/V SEA TENDER



Special equipment, including living vans needed to provide additional berthing space afloat for operating personnel, was flown from CONUS to Danang, where it was loaded aboard the SEA TENDER.

LIVING VANS OFFLOADING – DANANG

The Sea Search Group

Effective search and recovery operations required a 24-man team. Two elements of this group, the ship's crew and the at-sea search team, were embarked aboard the SEA TENDER. The third element, the shore search team, operated ashore.

To operate the SEA TENDER on a 24-hour-a-day basis, a crew of nine was required. In addition to the captain and mate, the crew consisted of a chief engineer, an engineman, two seamen, a cook, and two stewards.

The at-sea search team also consisted of nine people. A Military Representative and a Project Manager were present at all times, although both were replaced periodically during the operation. Other full-time members of the team included an assistant project manager, two side-scan sonar operators, two divers, and a diver tender. A representative from JCRC, the crash site investigator, was also present as required.

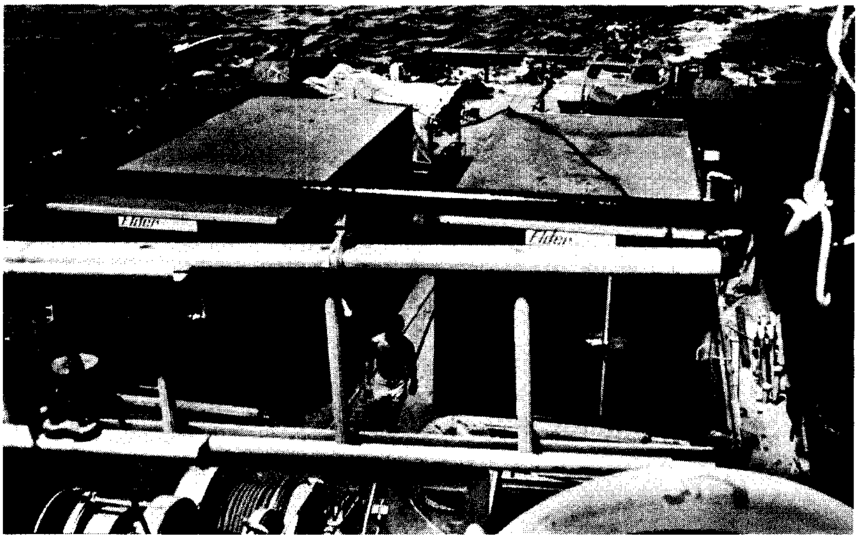
The Shore Team personnel consisted of a SUPSALV representative, a radio operator, three shore navigation personnel, and a Project Coordinator. The Coordinator, however, was not on-scene for the full duration of the project. In addition to maintaining and moving the navigation stations, the Shore Team provided necessary communications, coordinated with Vietnamese military and civilian personnel, and with consular and DAO officials; they also provided necessary transportation and supplies procurement.

Surface Support Platform – M/V SEA TENDER

The M/V SEA TENDER, owned by General Marine International, and sailing under the U.S. flag, was a 150-foot offshore supply vessel of 173 gross tons displacement. Based out of Singapore, the SEA TENDER was fully equipped with electronic navigation and communications equipment. The SEA TENDER provided a maneuverable and stable platform, both important criteria for this operation. Main propulsion was provided by two 3,000 hp diesel engines, with augmented maneuverability from a 150 hp bow thruster. The elevated pilot house allowed ample room for the normal three-man search crew (helmsman, sonar operator, and Project Manager) and their equipment. Messing facilities easily accommodated the full at-sea crew, and provided areas for off-shift rest and relaxation. A feature which added significantly to the ship's desirability for the operation was the clear 30-foot by 110-foot fantail area aft. This provided the required space for installation of search sonar, diving equipment, winches, air compressors, a portable recompression chamber

SEA TENDER's clear, spacious after deck provided needed installation and operating space for the large amount of special equipment needed in the search, diving and recovery work.

M/V SEA TENDER – AFTER DECK



SEA TENDER also provided space needed for extra living quarters required by the number of technical personnel involved in the operation.

LIVING VANS ON DECK

system, and two 8'x10'x26' living vans (required due to limited berthing accommodations). In addition, the ample fantail also had space for a diving station and for the stowage of recovered aircraft debris.

EQUIPMENT REQUIREMENTS

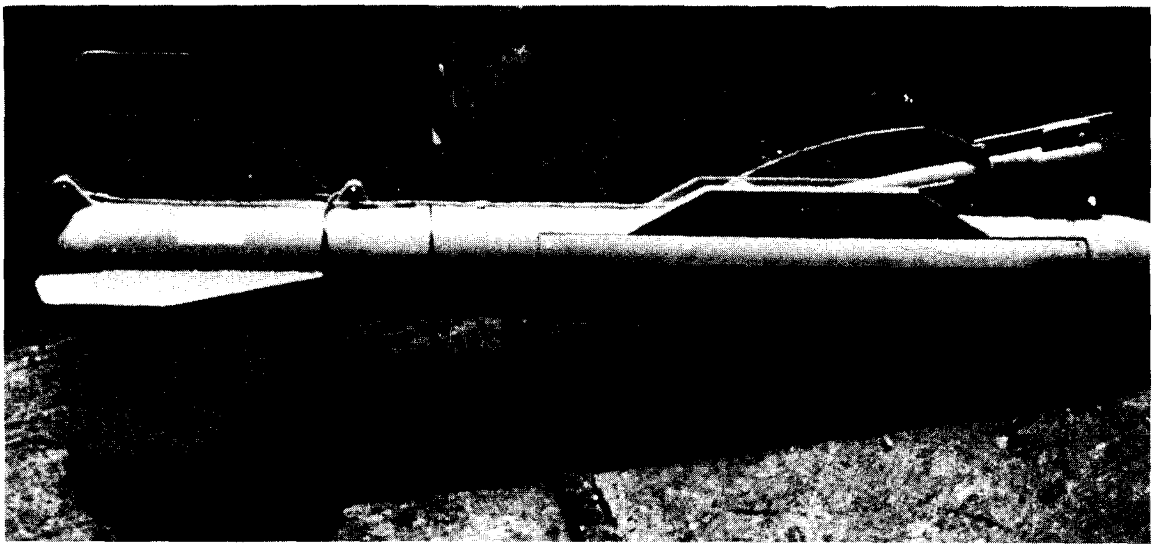
To effectively accomplish the assigned task, a number of sophisticated equipment systems were required. To locate objects under water in the search area, a specialized sonar system was needed. Once located, accurate determination of the position of the wreckage required a precision navigation system. Thereafter, divers with special gear would be required in order to identify the nature of the contact, and if it was aircraft related, recover necessary items.

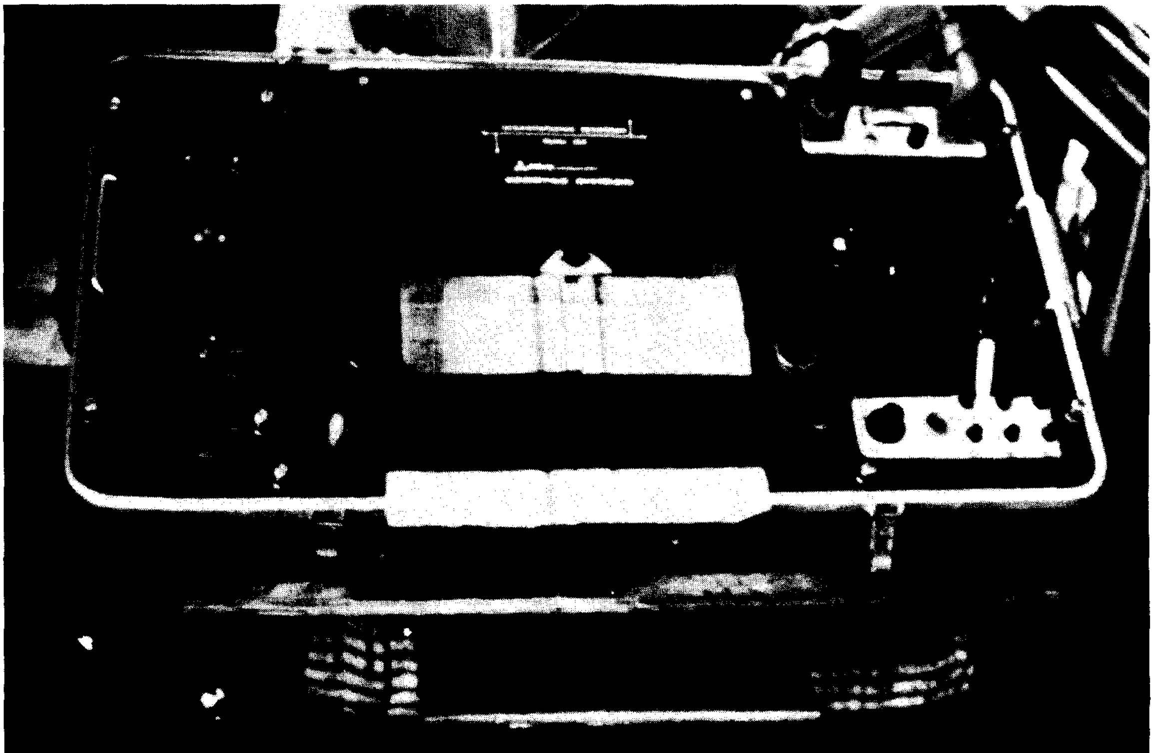
Search with Side-Scan Sonar

The primary search system used to locate objects on the bottom was EG&G dual side-scan sonar. This system is comprised of two basic units: a towed, streamlined "fish" carrying two sonar transducers, and a shipboard control unit. In these operations the control unit was located in the pilot house of the SEA TENDER. The recorder of the control unit converts reflected sound signals from directly below the "fish," out to a specified range on both sides, into a graphic record of the ocean bottom. Recorder range settings of 150-, 300-, and 600-feet-per-side were used for search and classification.

The duty sonar operator continuously examined the sonar trace as it came from the recorder and marked substantive observations with sequential fix numbers. The oncoming sonar operator, as well as the search manager, would review these traces prior to going on watch. When the nature of a finding could not be verified, it was reexamined by sonar. If the contact was interpreted as not being a natural part of the bottom, a marker buoy would be dropped and the contact verified by divers.

Search tracks run by the SEA TENDER were closely controlled so that, whenever possible, no course deviation in excess of 25 meters was permitted. Using a 600-foot sonar range, search tracks were spaced 600 feet apart. When search gaps occurred, that portion of the track was rerun. Search lines were spaced so that a given point of the bottom was observed twice. At times, however, holding a true course was made difficult by the ship's





The EG&G dual side-scan sonar consists of a towed streamlined fish and a shipboard control and recording unit.

BASIC COMPONENTS OF THE SIDE-SCAN SONAR SYSTEM

faulty steering gear. When this occurred, search track intervals were reduced to ensure thorough coverage.

Precision Microwave Navigation System and Procedures

Positioning of the search vessel was accomplished using a Cubic DM-40 Autotape precision electronic navigation system. This system is a range/range-line-of-sight type, with a useful over-water range in excess of 20 miles, accurate to ±5 feet. The range in meters to each of the two shore stations was continually displayed digitally on the receiver unit in the pilot house. Ranges of from 900 feet to 29 miles were used successfully.

After detection of a contact, several sonar runs were made on different courses to pinpoint the location. The precision navigation system would then be used to position bow and stern anchors for a two-point moor directly over the contact.

The precision navigation system used in the JCRC operation was based on two shore transmitters that generated continuous range data in the ship-installed receiving unit.

M/V SEA TENDER BELOW
A SHORE NAVIGATION SYSTEM TRANSMITTER

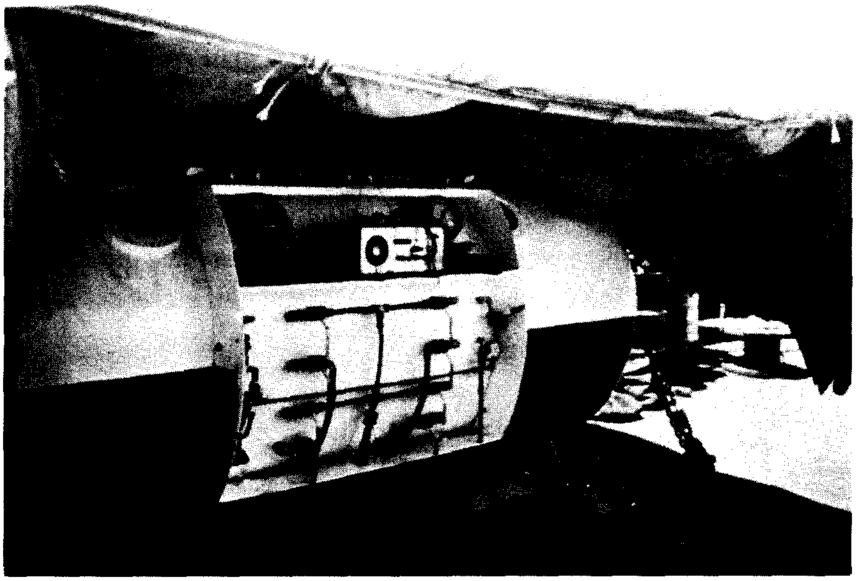
Eleven different shore stations were utilized during the operation. A significant effort was made to find and make use of shore station positions that provided for both operator security, during the uneasy truce in Vietnam, as well as effective navigation. Three men were required for shore station operation. Domestic power failures that occurred almost daily, and usually lasted several hours, required constant attention to storage battery maintenance or system shutdown would occur. Primitive living conditions made it mandatory to relieve crews periodically. While the personal security of shore personnel did not prove to be a problem, constant pilferage of food and personal equipment was a distracting nuisance.

Divers operated from the stern of the SEA TENDER using the surface-supplied-air Kirby-Morgan BANDMASK system predominantly. Standard SCUBA gear also was used in shallow water.

DRESSING THE DIVER

Diving Equipment and Arrangements

Two basic types of diving equipment were used. In shallow water, standard open-circuit SCUBA equipment was used. Most dives, however, were conducted with surface-supplied air, utilizing the Kirby-Morgan BANDMASK. This provided the advantages of an almost unlimited, continuously available air supply, and of diver voice communications with surface personnel.



A portable decompression chamber was installed aboard the SEA TENDER against the possibility of both air embolism and the need for decompression.

DECK DECOMPRESSION CHAMBER CONSOLE

A total of 140 dives was made to a maximum depth of 156 feet. A significant portion of the total diving time was expended uncovering heavily silted and otherwise buried wreckage. As both deep and shallow dives were conducted, the possibility of both air embolism and the need for decompression had to be considered. To provide this safety for divers, a portable recompression chamber was obtained. The chamber was also useful on deeper dives, in that it permitted surface decompression of the divers. The air required to run the chamber to depth pressures was provided by compressors. Pure oxygen was available when required for decompression or treatment of embolism.

Diving Procedures

Three diving personnel were used during dives. A standby diver was in constant communication with the working diver, keeping the dive depth-and-time log, and standing ready to assist in emergencies. A tender handled the umbilical and kept track of the diver's location and condition by observing the exhaled bubbles on the surface.

Diving from SEA TENDER involved a team of three: the working diver, a tender to handle lines, and a standby diver for diver phone communication and keeping the depth-and-time log.

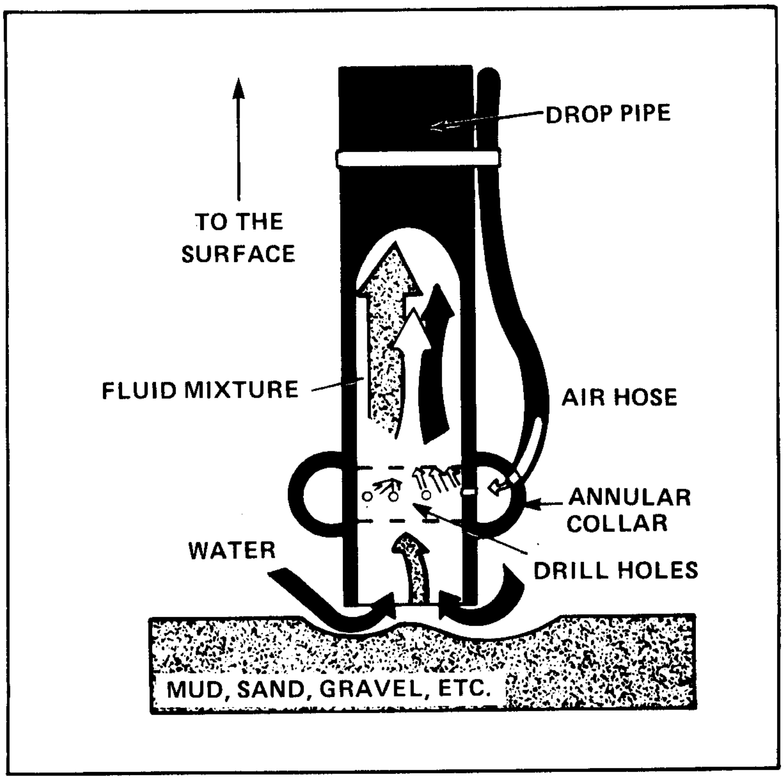
TENDING DIVER – BACKUP DIVER AT CONSOLE

Underwater Work

Diving operations were begun once the ship was moored over the contact. Divers then carefully searched the bottom of the contact area for aircraft wreckage. If the contact area search was successful it was followed by recovery of debris of interest. A variety of equipment, including winches, lift wires and slings, and a steel drum for the collection of small items, were used during recovery operations.

Air Lift

For buried debris, either a water jet or an air lift was employed to remove sand and silt. An air lift consists of a 30-foot length of 6-inch hose into which low pressure air is injected through an anular ring close to its lower end. This end is then injected into the buried debris. The air, rising and expanding toward the surface within the lift-hose carries sand, mud, and debris to the surface. This mixture was then discharged into a wire sieve where it was sorted, and items of interest, such as bone fragments and personal effects, were removed.



An air lift is particularly useful in recovering quantities of small debris from the bottom. The fluid-mixture of air and water is propelled to the surface carrying debris with it. This, in turn, generates the on-going process which picks up more water and debris at the air lift's inlet.

AN AIR LIFT WAS EMPLOYED IN RECOVERY WORK

Divers made many attempts to use a hand-held sonar to assist in locating debris on the bottom. However, interference and false signals from anchors and mooring lines caused problems; buried contacts proved difficult to detect. Actually, diver aiming of the side-scan sonar "fish" proved more effective. The greater sensitivity and visual record, rather than just an audible signal, provided better results compared to hand-held sonar.

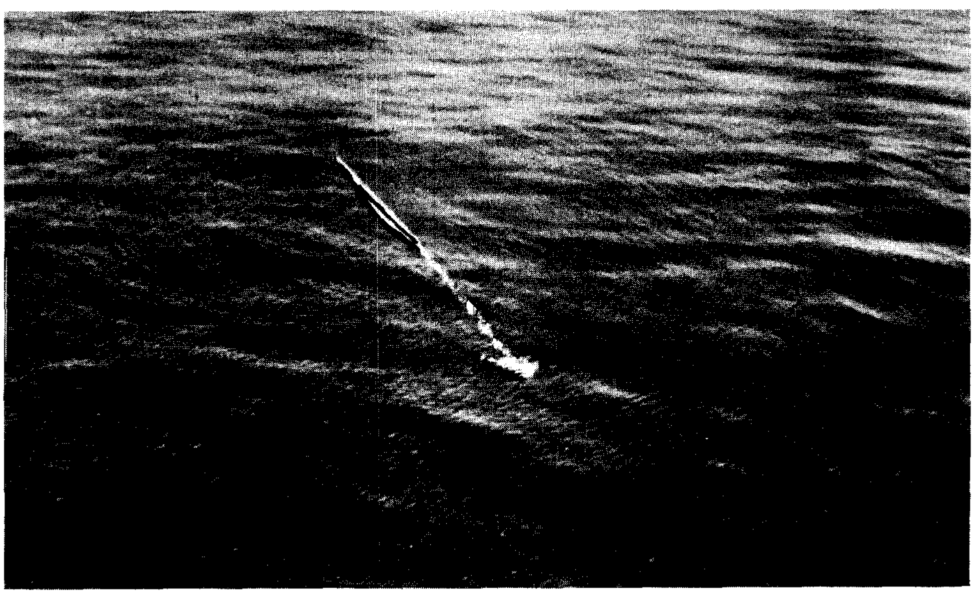
Photographic and television equipment was of limited value. Limited visibility and the widely scattered nature of the debris made this equipment relatively ineffective, and high humidity caused problems with the video tape recorder.

CONDUCT OF OPERATIONS

Initial Search and Salvage Operations

With shore navigation stations established and personnel and equipment in readiness, the SEA TENDER departed Danang at 1600 on 10 July for Search Area 1. Search operations began at 2235 the same night. With the exception of minor interruptions, these operations continued around the clock for the next 82 days.

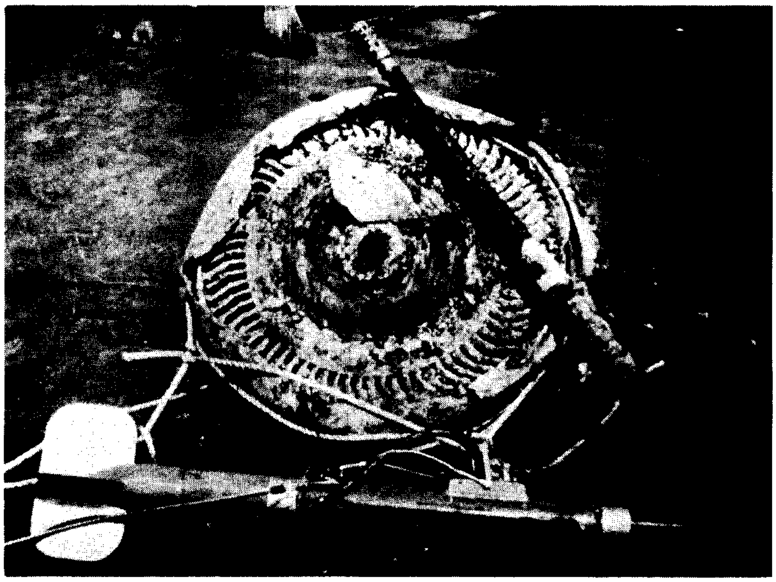
On 14 July 1973, the first contact requiring investigation was located. The sonar trace showed a fish haven – a collection of vertically anchored bamboo spars – with an unusual pile of debris nearby (Contacts 1 & 2). Initial attempts by divers to locate the debris were unsuccessful due to limited visibility and rough seas. However, in spite of these conditions, search continued, during which the sonar "fish" became fouled in the fish haven and was severely damaged. On 15 July, when the seas had abated, diving was resumed but poor visibility again prevented divers from locating the contact. Finally, with the side-scan sonar hung over the side of the vessel, Contact 3 was located approximately 70 feet away, and the



In shallow water off Vietnam, fish havens constituted a problem for sonar operation. These vertically anchored bamboo spars, on a number of occasions, became entangled with the towed sonar fish, parting the tow cable and damaging the fish.

FISH HAVEN – VISIBLE PORTION

SEA TENDER was moved to that position. In this new position, divers quickly located aircraft wreckage. Only 1 to 2 feet of wreckage was visible, the rest being covered with sand and mud. During two days of salvage operations, enough A-4 aircraft wreckage was recovered for positive identification. Recovered debris included a turbine, engine sections of the fuselage, a machine gun, and a gun actuator. Following an examination and a check of records by the Crash Site Investigator on board the SEA TENDER on 17 July, it could be determined that the A-4 wreckage was not of concern to the JCRC.



A jet-engine rotor and gun barrel were retrieved from Contact 3, an A-4 aircraft. They are shown here together with a side-scan sonar fish.

WRECKAGE RECOVERED FROM CONTACT 3

Search operations continued around the clock and the same day another contact (Number 4) was obtained. Diver investigation of this contact revealed an 80-foot boat. The following day another sunken craft (Contact 5) was also located and investigated.

Contact 6 – Accession Number 0435

While investigating Contact 5, a sunken boat, a piece of aircraft wreckage was found snagged in the stern anchor flukes. A sonar search of the immediate area indicated another debris pattern 150 feet to the south of Contact 5. By identification of the aircraft from recovered debris, it was determined that it was not of interest to the JCRC and this particular recovery could be discontinued.

Over the next four-week period, search and salvage operations continued, and 19 additional contacts were located. They included wreckage that could be identified as an F-4 aircraft, an A-7 aircraft, and three UH-1 helicopters, all of which were not of interest to the JCRC and could be eliminated from further investigation.

On 17 August, a message was received by the search team indicating that debris from Contact Number 6 had been identified as a probable EF-10B, accession number 0435, and that more positive identification was required. Operations were shifted back to Search Area 2, and the following morning Contact Number 6 was relocated. The SEA TENDER was positioned in a three-point moor over the contact and prepared for salvage operations.

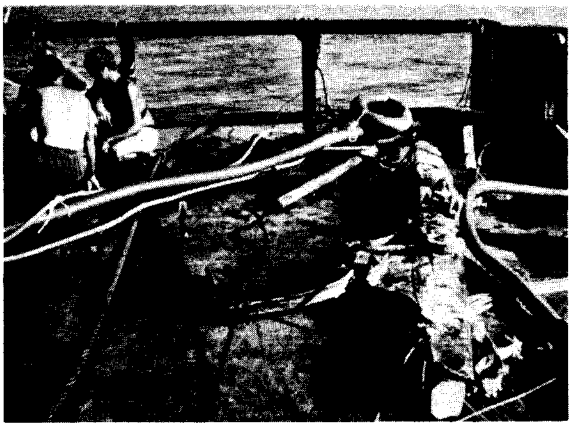
Diving operations were conducted in 156 feet of water, using the surface-air-supplied Kirby-Morgan mask. On the first day an extensive amount of debris was located and recovered, including a pilot's helmet bag. The debris was transported to Danang that evening, and the SEA TENDER returned to the salvage scene the next day. Diving and recovery operations continued for the next three days until the SEA TENDER was forced to put in to Danang for more oxygen, returning to the wreckage site the following day. Operations continued at this site until 27 August. In the meanwhile a large quantity of debris was recovered, including: a hydraulic actuator, turbine stator and blades, the right aileron, a gun assembly, and miscellaneous radio and electrical equipment.

Of most importance during this period were the recovery, on 24 August, of human remains. A single bone fragment, identified as the base of the fourth metatarsal, was recovered. While positive identification of the individual was impossible, enough material was collected to substantiate a change of status of 2 MIA to KIA/BNR.

It is interesting to note that the subject EF-10B aircraft was not originally believed lost in the area of recovery. Records indicated that it had crashed over land, more than 15 miles from where it was actually located. This provides an excellent example of the degree of inaccuracy of crash site data.

Contact Number 27

Upon completion of recovery efforts on Contact Number 6, efforts returned to Search Area 3. Then, on 30 August, a local fisherman directed the search team to the wreckage of



Contact 11 – UH-1 Helicopter rotor on stern of SEA TENDER, with air lift hose, in use for debris recovery.

Contact 12 – Tail of UH-1 Helicopter fuselage being recovered after long immersion.

Contact 14 – Debris of F-4 jet aircraft on deck of the SEA TENDER.

Contact 23 – Nose Wheel of A-7 jet attack bomber hauled to the side of SEA TENDER.

EXAMPLES OF RECOVERED AIRCRAFT WRECKAGE

an AH-1 Cobra helicopter in 15 feet of water, 8.5 miles northwest of Search Area 3. The wreckage had apparently drifted into the area, supported by a buoyant fuel cell. The fisherman's information that local inhabitants had buried one crewmember on a nearby hillside was passed on to the JCRC, and resulted in the recovery of the remains.

Contact Number 28 – Accession Number 5100

On 28 August, with the aid of another local fisherman, the wreckage of another helicopter was located close inshore of Area 3 and recovery operations were begun. Since the wreckage was located in 20 feet of water, the air lift could be used to enhance the effectiveness of recovery operations. Numerous small items and personal items, including several bone fragments, were recovered in this manner. On Thursday, 4 September, after excavating to a depth of 4-5 feet, a tail section with identification markings, UH-34D 149351, was recovered. This number did not coincide with any helicopter being sought, so recovery operations could be concluded with the marking data being forwarded to the JCRC.

On 6 September, however, communication from JCRC indicated that the UH-34 number 149351 corresponded to their accession number 5100. It was of interest for resolution of an aircraft loss thought to have occurred ashore. Again, with this aircraft as with Contact Number 6, it was thought to have crashed over land more than 15 miles from the actual location of the wreckage.

Efforts, therefore, were returned to Contact Number 28. Using the air lift, the site was excavated in a circle 45 feet in diameter to a depth of 9 feet. Numerous items, including bone fragments and sections of the aircraft, were recovered. Examination of the recovered bone fragments however, by the Central Identification Laboratory, determined that these fragments were not of human origin. When the area of major debris concentration had been thoroughly searched, operations at this site were terminated on 9 September.

COMPLETION OF OPERATIONS

Following resupply at Danang, search operations commenced again on 11 September. On the same day, pilot and co-pilot seats plus the rotor with sections of four blades, from another UH-34 were located in 25 feet of water and recovered. These were the only sections of the aircraft not buried in the sand. Using the air lift for excavation, operations continued at this site until 17 September. During this time numerous pieces of debris and bone were recovered, including one bone fragment from a spinal column. These fragments were forwarded to the Central Identification Laboratory for a determination of origin.

During the period 18 through 25 September, five more contacts were investigated, all of which proved to be non-aircraft related. However, on 26 September, another helicopter was located, this one a CH-46A. Although work was now plagued with mechanical failures of the ship's compressor and winch, and with bad weather, operations continued with numerous sections of the aircraft being recovered.

On 29 September, however, a message was received advising of the need for the services of the M/V SEA TENDER in salvage operations at Triton Island (see page 46). Accordingly, after evaluating the status of operations, it was decided to terminate the program and the SEA TENDER returned to Danang the following day. Equipment was immediately offloaded, and the SEA TENDER departed for Triton Island the following day.

PROBLEMS ENCOUNTERED

Throughout the operation a number of problems resulted in frequent delays or postponement of operations. The primary problem areas are discussed below.

Erroneous Crash Site Data

The data provided by the JCRC concerned with the crash site location was frequently in error. Substantial error, of course, was anticipated, considering that the original positions were reported under wartime conditions – often without benefit of eyewitness information. Locations of the aircraft, accession numbers 0435 and 5100 respectively, are prime examples of the degree of site location error. These aircraft, it will be remembered, were originally believed to have crashed over land, but were located at sea more than 15 miles from the recorded location. With this degree of error, locating a specific aircraft proved extremely difficult.

Concealment of Wreckage

Because all aircraft located were buried at least 90 percent, a number of time-consuming problems resulted. Unlike that of new wreckage, the sonar picture was frequently difficult to identify. Positive identification of the actual aircraft was substantially more difficult, since the parts that could provide identification were usually buried. The need to recover remains or other delicate, destructible items substantially increased the time required to search and carefully excavate the wreckage.

Seaway congestion from fishing boats and floating nets hampered progress at night, and frequently even caused suspension of night search operations. The presence of numerous fish havens caused even more concern. Damage to towed sonar "fish" occurred several times, and on two occasions sonar "fish" were completely lost. These fish havens, when located near wreckage sites, tended to conceal debris, thus further restricting progress.

Material problems aboard the SEA TENDER also resulted in a variety of delays. The deck winch used for lifting aircraft debris was difficult to properly control. Several times this resulted in parting of the lift wire, causing loss of dive time while rerigging. Also, toward the end of the operation, the ship's steering machinery deteriorated. This was finally determined to be the result of adding liquid detergent, which had been mistaken for hydraulic fluid, to the hydraulic system. This so severely damaged the system that it had to be entirely rebuilt.

Communications, of two types, created problems. Language difficulties frequently arose with the Vietnamese translators, whose command of English was not satisfactory. Radio communications with the Seventh Fleet also was a problem. After long delivery delays however, installation of required crystals in radio equipment of the SEA TENDER resolved this situation.

CONCLUSIONS

The SUPSALV search and recovery team conducted a thorough search of offshore areas in support of operations for the JCRC in Southeast Asia, using towed side-scan sonar locators and precision navigation based positions from shore electronic units. Some of the lost aircraft designated by JCRC were located. In the other cases, the majority, a thorough search at least reliably established that the downed aircraft was not in the area of the last reported position.

Several factors combined to preclude a high probability of recovery:

- Wreck disintegration by the sea;
- Silting;

- Floor litter and a variety of man-made or natural bottom obstacles;
- And, imprecise crash site data – by far the most difficult problem.

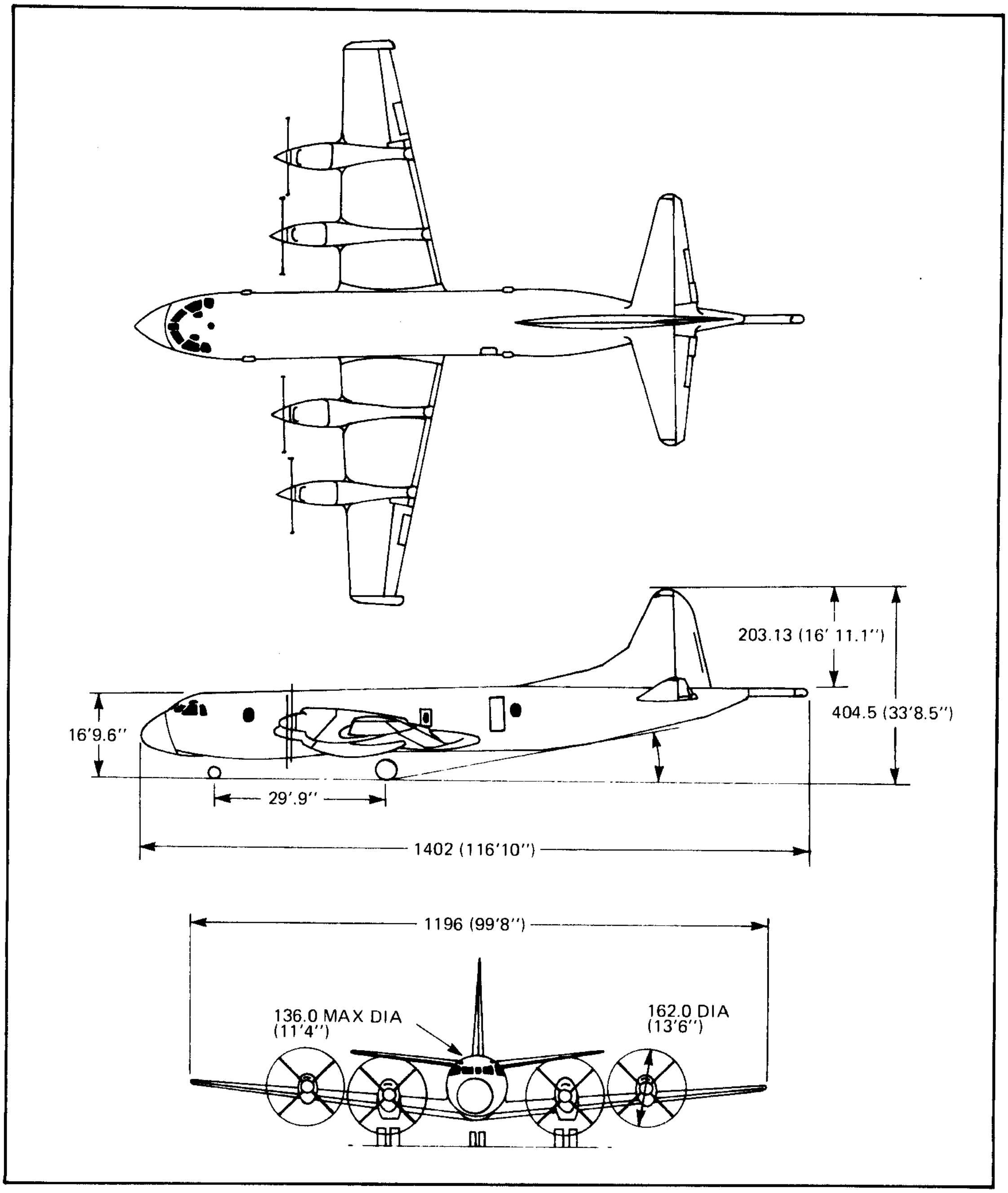
Since the majority of at-sea MIA and KIA/BNR crash sites are based primarily on the "last reported position" the probability and degree of error is substantial.

The conclusion follows that this type of operation is not too feasible without more accurate location data and/or some of the physical factors being more favorable.

RECOVERY FOR CRASH ANALYSIS

OF P-3B AIRCRAFT OFF

BRUNSWICK, MAINE



The loss of a P-3B operating from NAS Brunswick, Maine, in March 1973, led to recovery operations for accident cause analysis. Because a high percentage of P-3B losses at the time were due to unknown causes, location and recovery of the wreck was considered vital.

U.S. NAVY P-3B ANTISUBMARINE PATROL AIRCRAFT

RECOVERY FOR CRASH ANALYSIS OF P-3B AIRCRAFT OFF BRUNSWICK, MAINE

INTRODUCTION

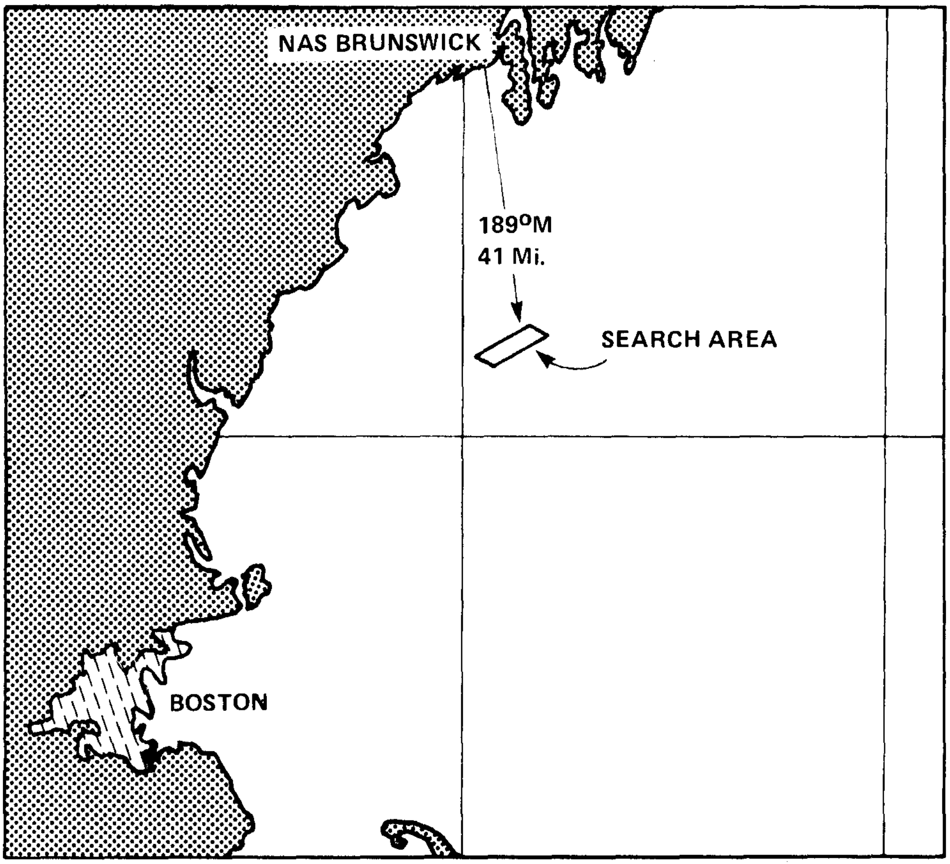
On 15 March 1973, a U.S. Navy P-3B aircraft, while on a routine training flight, crashed into the Atlantic Ocean off Brunswick, Maine. Shortly after the crash, smoke flares and floating debris were sighted by the crew of another P-3B aircraft. A thorough search of the area, conducted by Navy and Coast Guard units, revealed more wreckage but failed to locate any trace of the crewmen of the missing aircraft. Because a high percentage of P-3 losses were due to unknown causes, location and recovery of the wreckage was considered vital.

The U.S. Navy, Coast Guard, Ocean Search Incorporated, and Seaward Incorporated combined efforts to accomplish this task. Search was commenced 20 March, and the wreckage was located next day. Salvage operations were conducted by the ALCOA SEAPROBE, supported by the USS EDENTON (ATS-1). Making use of the unique capabilities of the ALCOA SEAPROBE, the wreckage was accurately and completely photographed and plotted. From this data, critical pieces of wreckage were selected for recovery. In just nine days of actual salvage operations, all pieces of wreckage required by the Accident Investigation Board to accurately determine the cause of the crash were recovered. Utilization of the ALCOA SEAPROBE and other modern systems permitted this operation to be successfully completed in an efficient, expeditious manner.

LOSS OF THE AIRCRAFT

Circumstances of the Crash

On 15 March 1973, at 11:42 EST, P-3B aircraft, Bureau Number 152749, departed the Brunswick, Maine, Naval Air Station (NAS), on what was to have been a routine pilot-training flight and post-maintenance check of number 3 engine. When the aircraft was 25 miles out, the Brunswick tower lost radar contact with it. At 12:45 PM, crewmen of another P-3B aircraft sighted floated wreckage, an oil slick, and two burning smoke flares. The position of the wreckage as plotted by the P-3B crew was 175°T from NAS Brunswick, at a range of 41 miles.



The missing P-3B, on a routine flight, was lost from the NAS Brunswick radar 25 miles out over the Atlantic. Immediate, intensive search revealed wreckage that established a search area 41 miles from the station.

THE P-3B WAS LOST ON A LOCAL OVER-WATER TRAINING AND TEST FLIGHT

Immediate Search Operations

An intensive air and sea search for the five missing crewmen was initiated immediately. Navy and Coast Guard fixed wing and helicopter aircraft, assisted by several Coast Guard vessels, searched unsuccessfully until the afternoon of the 17th, when the search was discontinued.

Requirement for Recovery of Wreckage

Of the nineteen aircraft of this type which had been lost, P-3B number 152749 was the tenth to be lost from an unknown cause. Because of this high ratio of crashes from unknown causes, it was considered vital that the reason for this mishap be identified. Accurate determination of the cause of this crash could result in the identification of an unrecognized structural weakness in this type of aircraft, a requirement for changes in operational procedures, or other means of preventing future mishaps. To accurately determine the cause of the crash, selected pieces of wreckage had to be recovered and visually inspected.

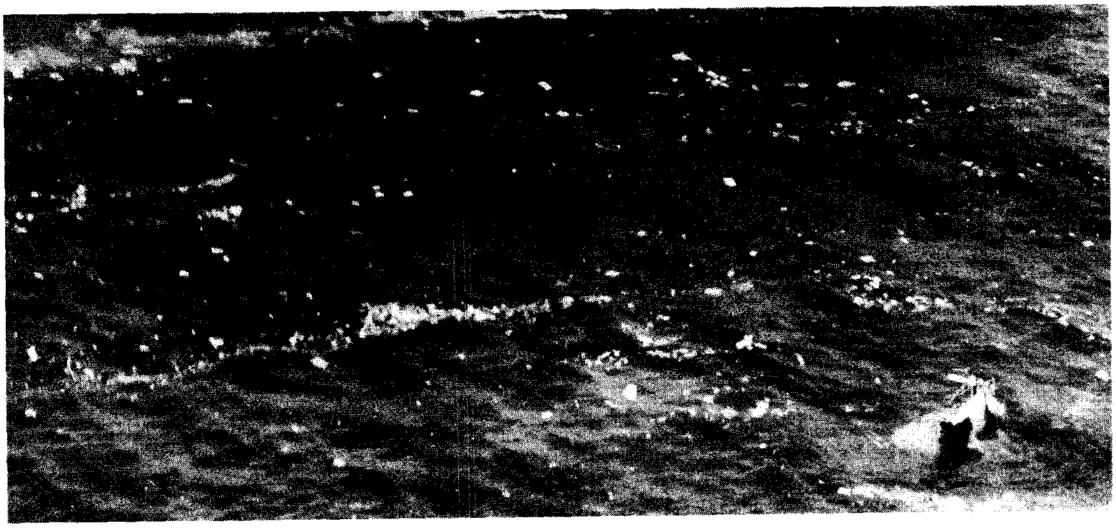
P-3B SEARCH OPERATIONS

Survey Team

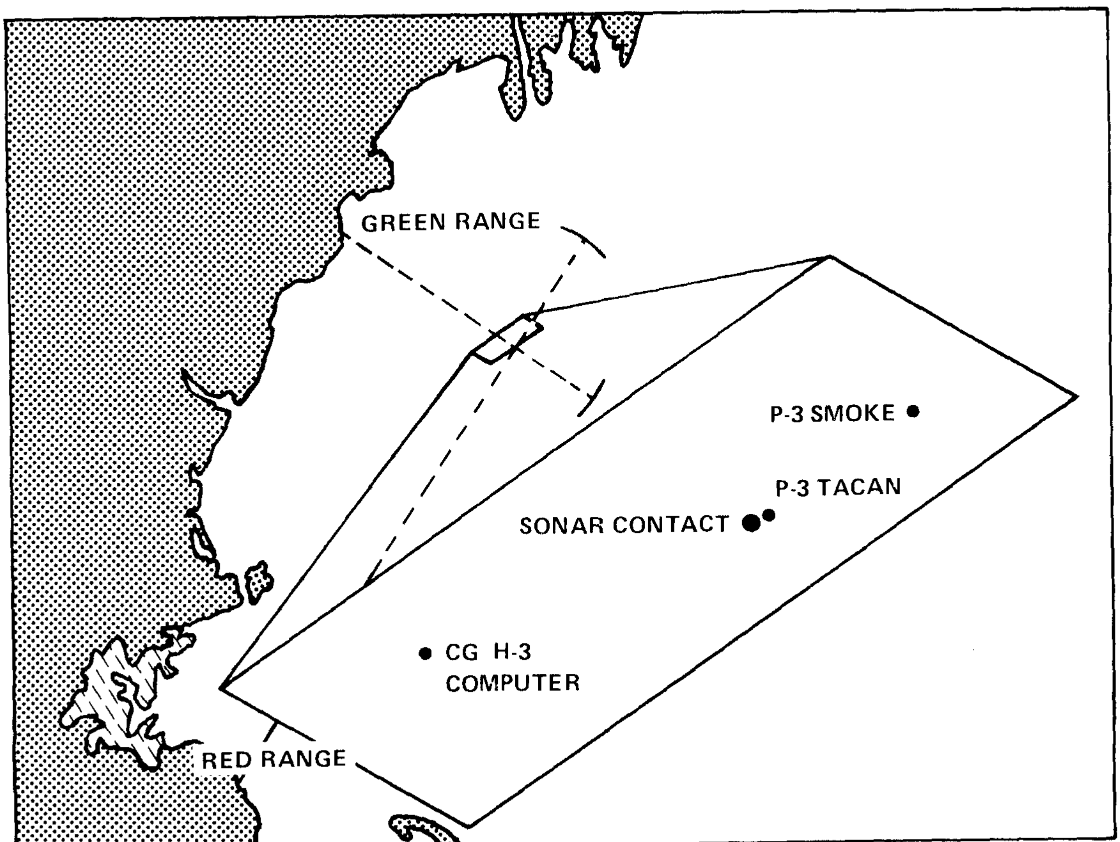
On 17 March, the Commander, Naval Air Forces, U.S. Atlantic Fleet (COMNAV-AIRLANT) requested the Supervisor of Salvage (SUPSALV) to assist the Navy Accident Investigation Board in the location and recovery of the missing aircraft. Representatives from SUPSALV and Seaward Inc. arrived at NAS Brunswick the next day. They met with representatives from the Accident Investigation Board and the missing aircraft's squadron, including the pilot and navigator of the P-3B who had sighted the wreckage initially. The following day, the SUPSALV representative met with the Portsmouth Naval Shipyard Salvage Officer and representatives of the U.S. Coast Guard to formulate plans for the sonar search. At this meeting the 110-foot Coast Guard tug CGC YANKTON (WYTM-72), stationed at South Portland, Maine, was designated as the search platform.

Establishing the Primary Search Area

The position of the wreckage was plotted by several different units shortly after the crash. The first to establish datum was the P-3B which discovered the wreckage. This position was 175°T (189°M) at a range of 41 miles from NAS Brunswick. The first Coast Guard rescue helicopter on the scene also established a datum, using its onboard computer, 5 miles to the southwest of the original position. Another P-3, using TACAN, plotted a position approximately 3 miles to the northeast of the original datum. From the above information a primary search area 3 miles wide and 8 miles long, in the shape of a parallelogram with northeast to southwest axis, was established.

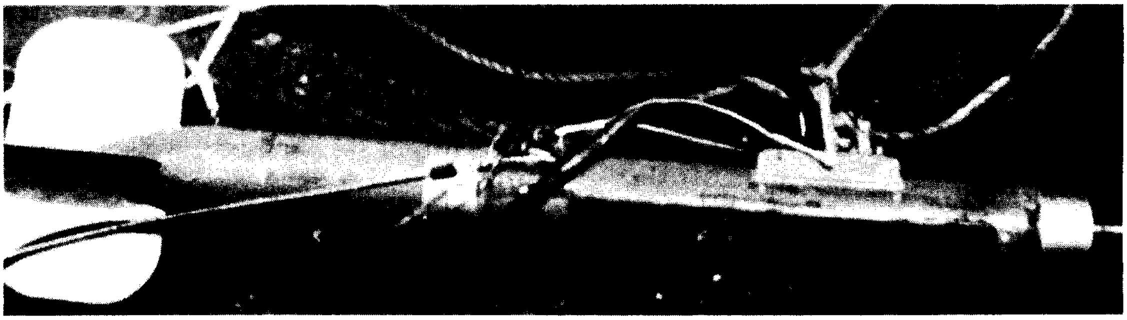


Floating wreckage and smoke flares helped to establish a search area.

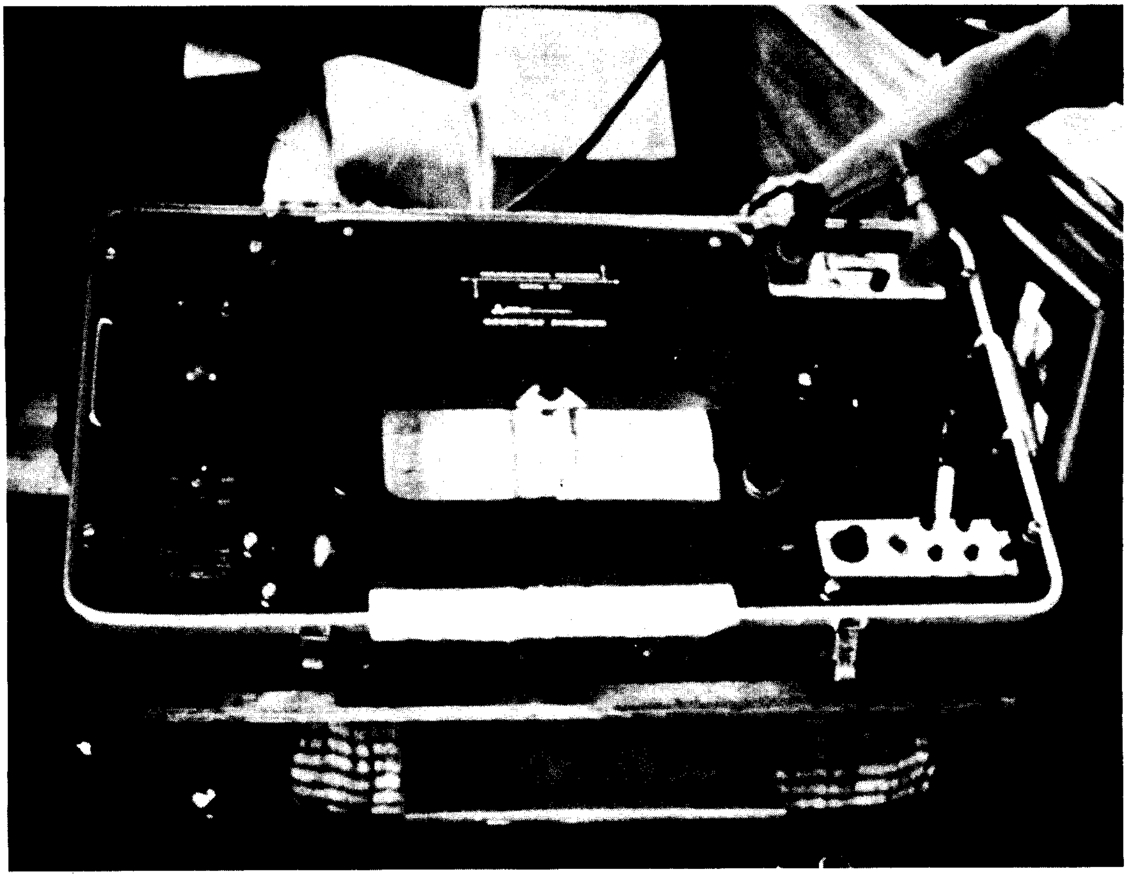


The 3- by 5-mile search area was established by the Navy and Coast Guard shortly after the crash.

AN INITIAL STEP WAS TO ESTABLISH A SEARCH AREA



The towed sonar "fish" carries the sound source which produces the signal that is reflected by detected targets. Is also carries transducers that pick up the reflected signals to port and starboard of the search track.



The sonar recorder converts the reflected sound signals into a graphic display.

BASIC ELEMENTS OF THE BOTTOM-SCAN SEARCH SONAR

Equipment Requirements

To conduct an effective search, two types of equipment were required. First, a precision navigation system was needed that would permit the survey team to accurately establish its position, conduct a search without excessive overlap or gapping, and most importantly, be capable of establishing and locating a given position. Second, a sonar system that would allow a rapid bottom search was required, one that nonetheless was sensitive enough to detect any important targets.

For navigation purposes a D.R. Raydist Precision Navigation System was selected. The system is comprised of two transmitter stations (red and green) located at selected sites ashore, and a receiver unit on board the vessel. The distance to the two transmitter stations is continuously monitored and plotted at the receiving station, allowing for accurate positioning within 2 feet at the full range of the system. The high precision and repeatability of this system permitted the search to be conducted along parallel, overlapping search tracks.

The primary search tool used to locate the aircraft wreckage was an EG&G Company dual side-scanning sonar. This system is composed of two primary components: a towed "fish" on which two sonar transducers are mounted, and a shipboard control and recorder unit. The recorder converts reflected sound from the signals of the "fish" into a graphic display of the ocean bottom. Several ranges are available, including a 600-foot range path for general search, and a 300-foot range path for detailed analysis of signals.

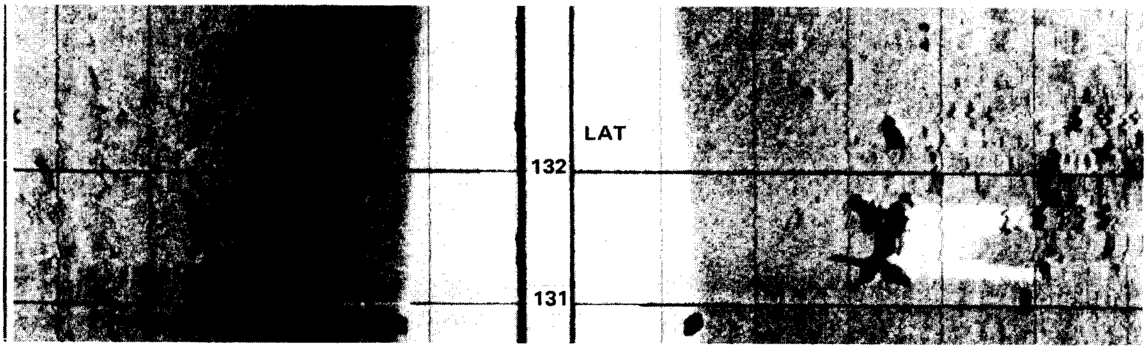
CONDUCT OF SEARCH OPERATIONS

Installing Equipment

Concurrent with the planning conferences on 18 and 19 March, two navigation transmitter stations were set up. The red station was located on the Massachusetts coast, south of Boston at 42°10'N and 70°42.5'W. At the same time, the green station was established at Fletcher's Neck near Biddeford, Maine, at 43°27'N and 70°20.5'W. Shipboard navigation and sonar equipment were installed aboard the CGC YANKTON.

Search Operations

Search operations commenced on Tuesday morning, 20 March. Initial tests of equipment and search were conducted in the southwest section of the search area, near the



Graphic sonar plot of the ocean bottom area in which P-3B wreck was found. The diagram below identifies various items of wreckage.

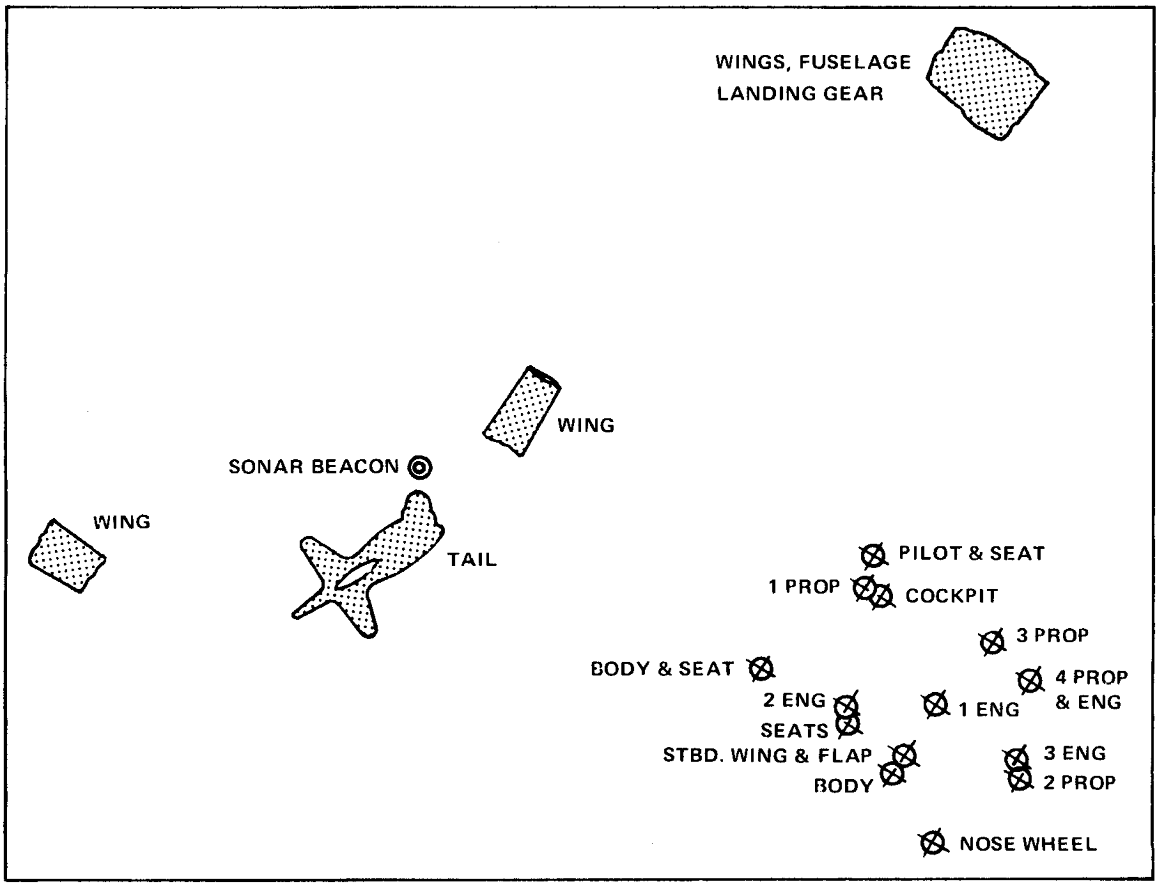


Diagram of the P-3B wreckage found by the search sonar. The items were identified by means of ALCOA SEAPROBE's closed-circuit TV and, for items of aircraft accident analysis importance, by actual recovery.

SEARCH SONAR LOCATION OF P-3B WRECKAGE

crash datum established by the Coast Guard helicopter. Later that morning a P-3B dropped a smoke flare to mark the estimated TACAN position, which was to the northeast, and search operations were shifted to this new area. Shortly after starting sonar search in this area, the sonar fish struck bottom and was lost. The sonar cable was retrieved, a new sonar fish rigged, and SEARCHOPS continued. By 2400, approximately 3 1/4 square miles had been searched.

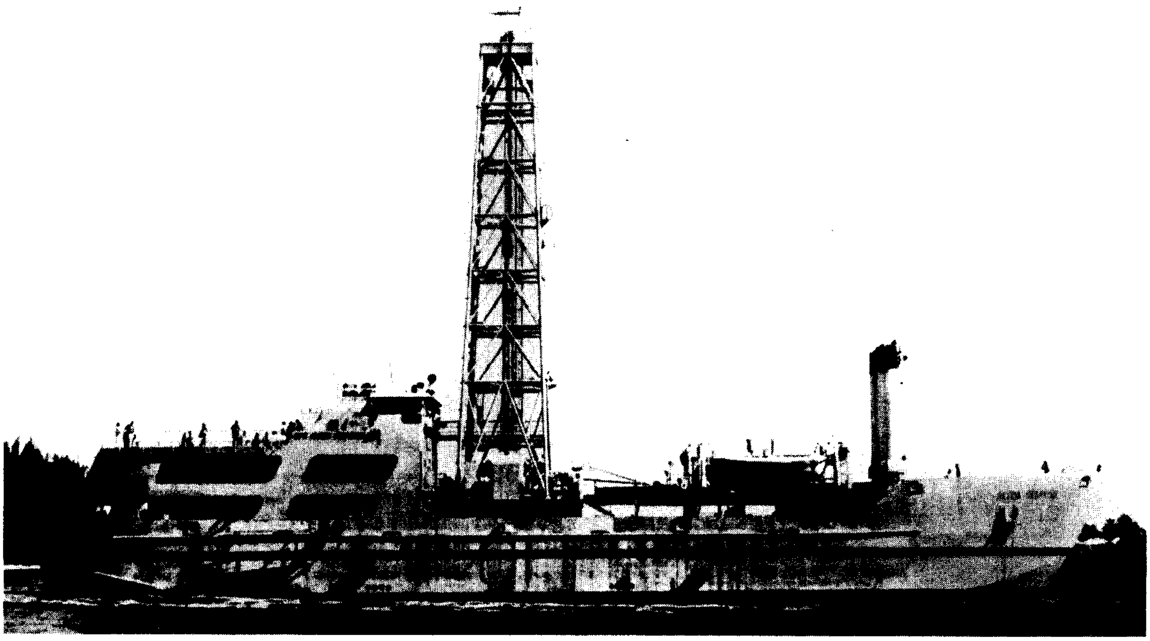
The next morning at 0842, after searching an additional 3 square miles of ocean, a solid sonar contact was registered. The contact was confirmed on the next routine pass of the search pattern. The pattern search was discontinued, passes were run on the contact, and determined that it was the missing P-3B. The wreckage was located in 573 feet of water, at 43°13.1'N and 69°49.3'W, 12 feet west of the position as established by the P-3B that originally sighted wreckage.

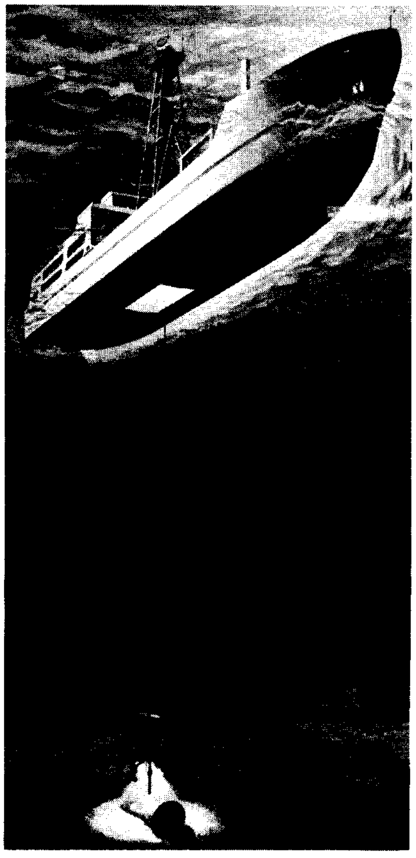
P-3B SALVAGE OPERATIONS

Salvage Requirements

Because of the depth of the water and the scattering of the debris, a salvage platform was required that was capable of moving freely over the wreckage area yet fixed in one spot during actual recovery operations. As the sonar traces indicated that the wreckage was relatively intact, a support platform with a large lifting capability was required. The depth at which the operations were to be conducted, and the maneuverability requirements, eliminated the use of a standard salvage vessel. To meet these requirements, the services of Ocean Search Inc. and their ALCOA SEAPROBE were secured.

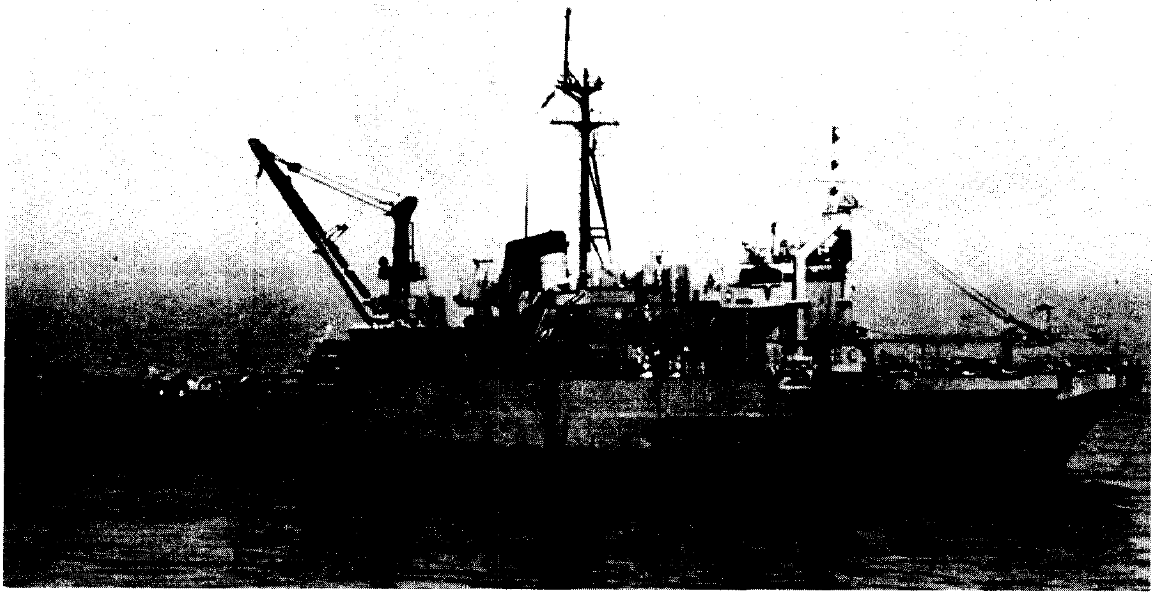
The ALCOA SEAPROBE was designed specifically for deep ocean search and recovery, and has several built-in systems that were ideal for this operation. A built-in position determining system, consisting of an acoustic beacon planted on the bottom and hull mounted hydrophones, used in tandem with the D.R. Raydist navigation system during the search phase, permitted precise positioning on the open ocean. Precise positioning is accomplished by two Voith-Schneider cycloidal, omni-directional propulsion units that allow the vessel to hover in one spot, in up to 6-foot seas without any mooring gear. The semi-flexible probe, from which the vessel's name is derived, consists of a system that connects and deploys 60-foot segments of 4.5-inch industrial drill pipe from the amidships "oil rig" and lowers it through a center well in the SEAPROBE's bottom. A cable affixed to the *exterior* of the pipe provides the necessary electrical power, control signals, and data transmission between shipboard control consoles and the working end of the probe. The





The ALCOA SEAPROBE uses an oil-drilling pipe-string as the core of its bottom search and underwater work system. The sections of 4.5-inch aluminum pipe are assembled and lowered by means of the derrick and drawwork on deck amidships. The semi-rigid pipe-column carries a working package at its lower end consisting of sonar, lights, closed-circuit TV, and manipulated tool systems as required.

ALCOA SEAPROBE WAS USED TO RECOVER AIRCRAFT WRECKAGE FOR ACCIDENT ANALYSIS



The services of USS EDENTON (ATS-1) were obtained to augment ALCOA SEAPROBE's lift capacity.

EDENTON joins ALCOA SEAPROBE on-scene.

ALCOA SEAPROBE AND EDENTON COORDINATED RECOVERY WORK

Control center of ALCOA SEAPROBE. Personnel are observing underwater TV, which was used to identify wreckage as that of missing aircraft. The console is adjacent to controls used to manipulate the TV camera and the underwater working rig deployed at end of ALCOA SEAPROBE's drill string of aluminum pipe.

MONITORING ALCOA SEAPROBE'S UNDERWATER TV

system is designed to search, sample, and drill down to 3,000 fathoms, and to recover up to 200-ton loads from 1,000 fathoms. A thruster system at the working end provides precision control for positioning of sensor packages, recovery mechanisms, or viewing or recording systems such as closed-circuit TV.

To provide for a large lift capacity, the services of the U.S. Navy salvage ship USS EDENTON (ATS-1) were obtained from COMSERVRON 8. In addition to the lift capacity, the EDENTON provided a large, open fantail area that was ideal for the stowage of recovered wreckage.

Photographing and Plotting the Wreckage

On 3 April, the ALCOA SEAPROBE arrived at the Portsmouth Naval Shipyard. The following day the USS EDENTON (ATS-1) arrived and all preparations were completed. Sailing was delayed for two days by adverse weather, and it was not until 6 April that both ships got under way for the crash site, arriving at approximately 2000. First on the agenda was the identification of the wreckage. A search pod was deployed, and by 2400 the wreckage had been positively identified as that of the missing aircraft.

Operations continued on a 24-hour-a-day basis. Utilizing a search pod and ALCOA SEAPROBE's unique maneuvering ability, the wreckage was carefully photographed and plotted. The search pod proved ideal for this purpose. Side-scan sonar allowed all wreckage to be quickly located. Once located, the wreckage was recorded by both 35mm still photography and on video tape using a color television camera.

To provide for still more accurate debris mapping, and to allow the ALCOA SEAPROBE to return to specific pieces of wreckage, an Acoustic Ship Positioning System was used. This system consists of an acoustic beacon implanted on the bottom, and hydrophones on the ALCOA SEAPROBE. The beacon, which was implanted near the P-3B's tail section, transmits an acoustic pulse which is received by three hydrophones permanently mounted on the hull of the ALCOA SEAPROBE. By means of computers, the slight difference in the time of receipt of the pulse is resolved into the position of the ship relative to the beacon. Thus, the beacon acted as a fixed reference point from which the ALCOA SEAPROBE could accurately determine its position.

Distribution and Condition of Wreckage

Contrary to original belief, the aircraft itself was badly broken up from impact. The majority of wreckage was concentrated in an area roughly 400 feet by 400 feet. The largest

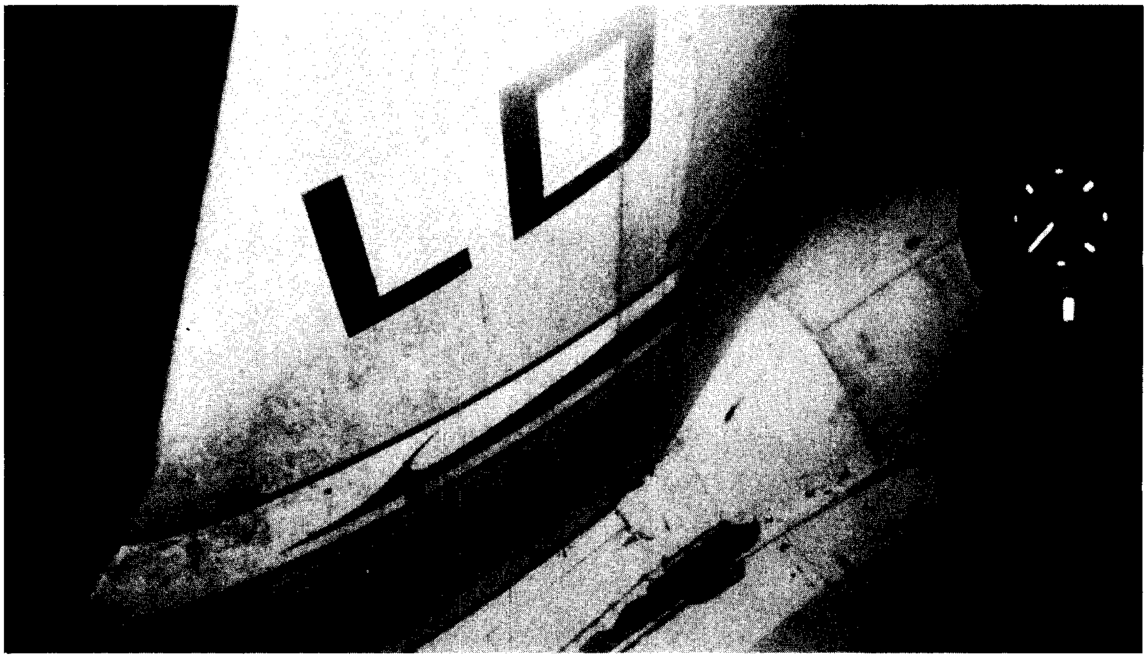
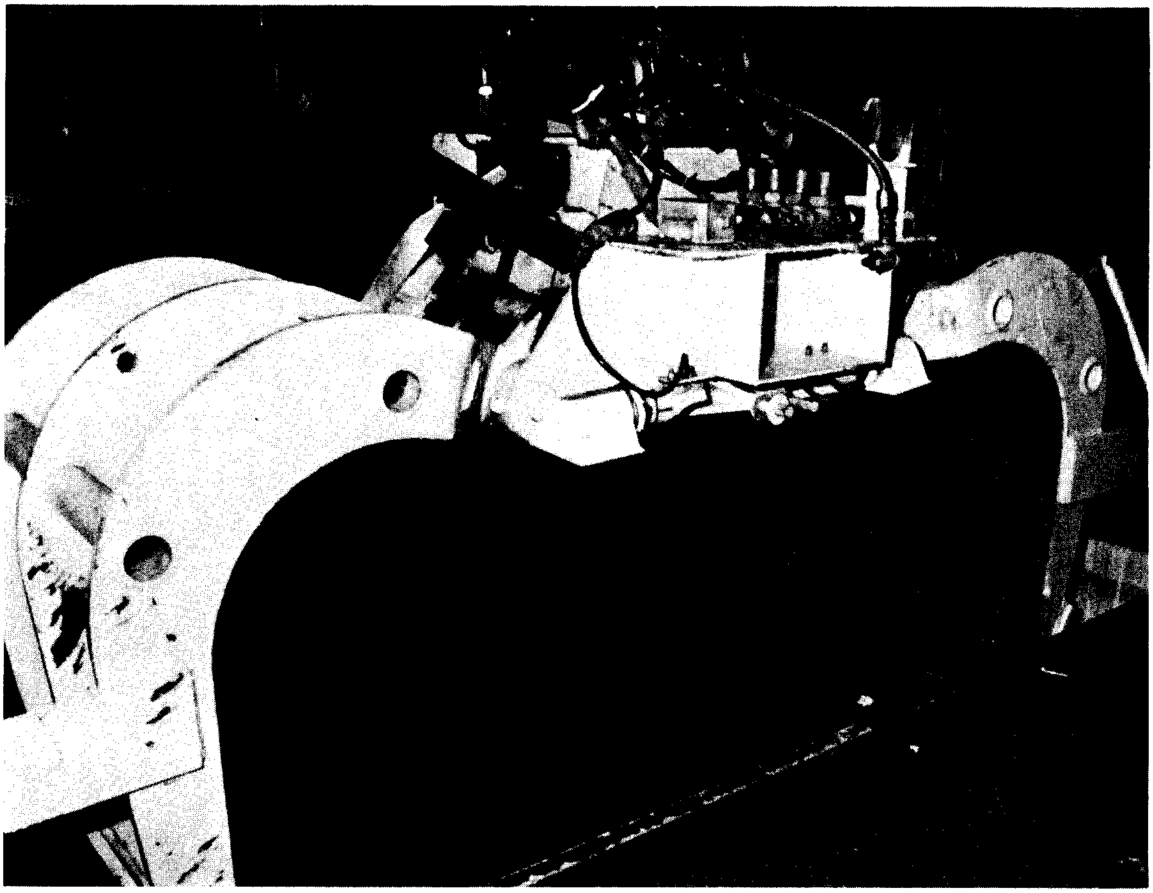


Photo of TV picture of P-3B's tail section. Bureau number of aircraft, 152749, is easily identifiable.

TV photo of fuselage wreckage of P-3B showing badly broken condition of aircraft.

UNDERWATER TV VIEWS USED TO IDENTIFY WRECKAGE



Mechanical grabber element with which ALCOA SEAPROBE's pipe-string was configured for the P-3B wreckage recovery. The grabber is remotely directed from ALCOA SEAPROBE's control center, under TV observation.

EQUIPMENT USED TO RECOVER AIRCRAFT WRECKAGE

section was the tail, which was intact with approximately 40 feet of fuselage attached. Other large pieces included sections of wing and a section of fuselage. Many of the smaller pieces of wreckage were buried in the mud bottom. Visibility at the bottom averaged 15 feet.

Wreckage Recovery

First to be recovered were the remains of a crewmember located during the mapping operations. On the first attempt, the aircraft's forward landing gear was accidently snagged by the grapnels used and was recovered. On the second attempt, the remains were successfully recovered and transferred to NAS Brunswick by helicopter.

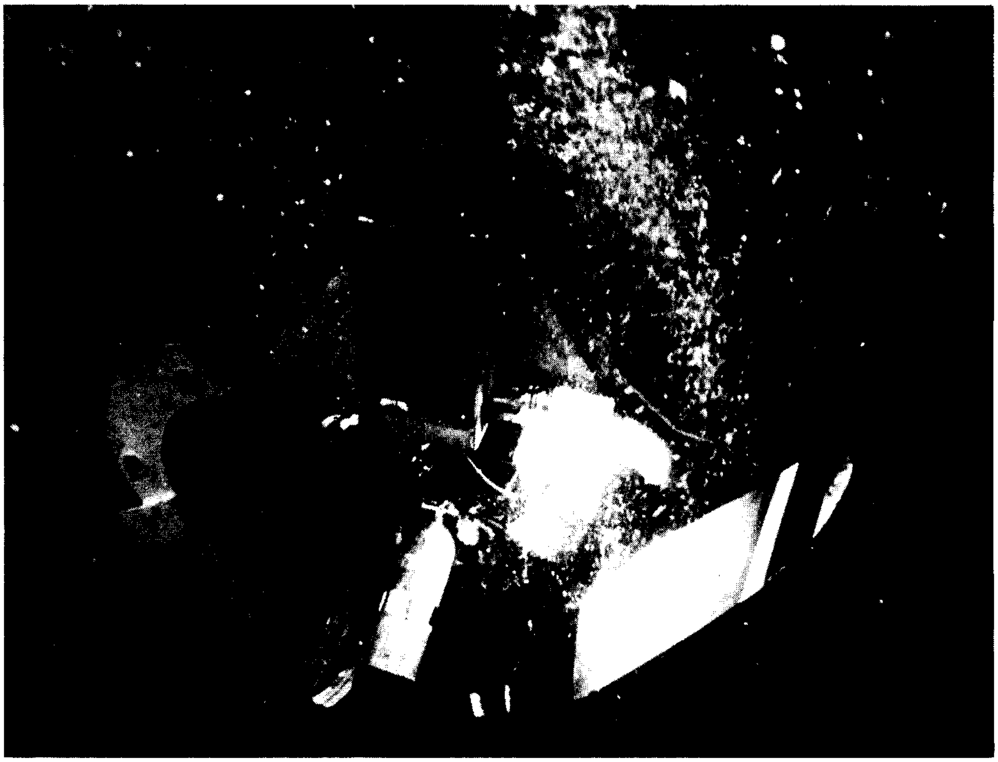
The grapnels, then, were exchanged for a mechanical grabber and the recovery of wreckage began. During the initial recovery attempt the grabber failed to open and had to be recovered to replace a ruptured fitter element in the hydraulic system. The grabber was again lowered to the bottom to recover a section of the starboard wing and flap, important because it included the flap screw jack fully extended.

Up to this point, all recoveries had been made through SEAPROBE's centerline well. However, difficulties were experienced handling debris in the confined well deck compartment and future recoveries of wreckage were made over the side. This was easily and efficiently accomplished by having divers attach crane-connected straps to the wreckage while it was still at a depth of 40 to 50 feet. The grabber was then released, allowing the wreck to swing out from under the SEAPROBE to be hauled aboard the EDENTON by a shipboard crane.

The remains of a second crewmember and a propeller were successfully recovered next; then, the number 4 propeller and engine were designated for recovery. However, efforts were continually frustrated with a problem that developed with the grabber. The propeller and engine assembly was grabbed numerous times only to have the jaws creep open and the load lost during each lift. The grabber was recovered and the problem diagnosed as slippage of the mechanical brake. The lock was modified and again the grabber was lowered. The repairs proved unsuccessful and the jaws continued to creep open under load until a friction brake assembly was installed. This modification was successful, and after 24 hours of frustrating attempts, the number 4 propeller (which had broken away from the number 4 engine during previous salvage attempts) was recovered.

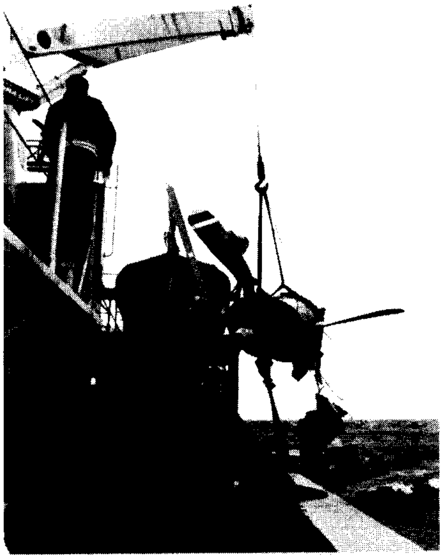
Salvage operations were temporarily suspended at 0900 on 10 April due to adverse weather. The salvage force rode out the storm at the site and, early on 12 April, the seas abated to where salvage operations could be resumed.

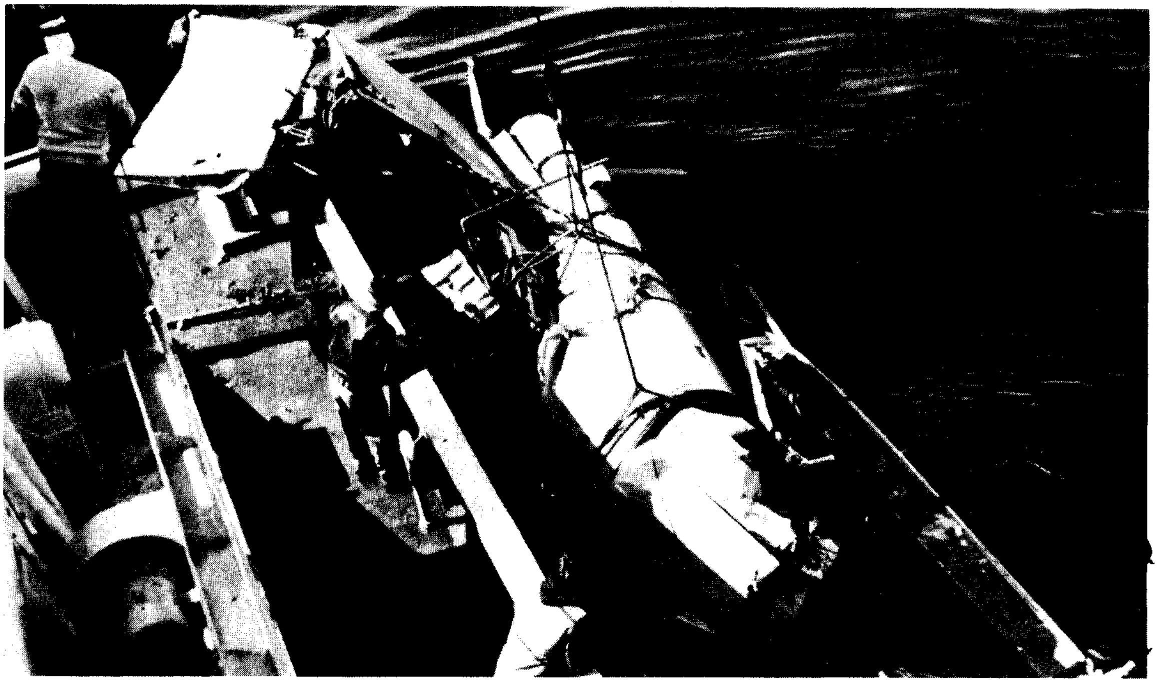
Operations continued around the clock for the next four days with no major interruptions. On 12 April, number 2 propeller and a section with three seats were recovered. The following day number 2 engine and nacelle were grabbed and brought on deck, and another propeller assembly located. On 14 April, number 3 engine, the remains of a 3rd crewman, the copilot's section of the cockpit (with associated instruments), and number 1 engine with a section of wing, were recovered. On Sunday, 15 April – the final day of the operation – number 4 engine and a final propeller were salvaged.



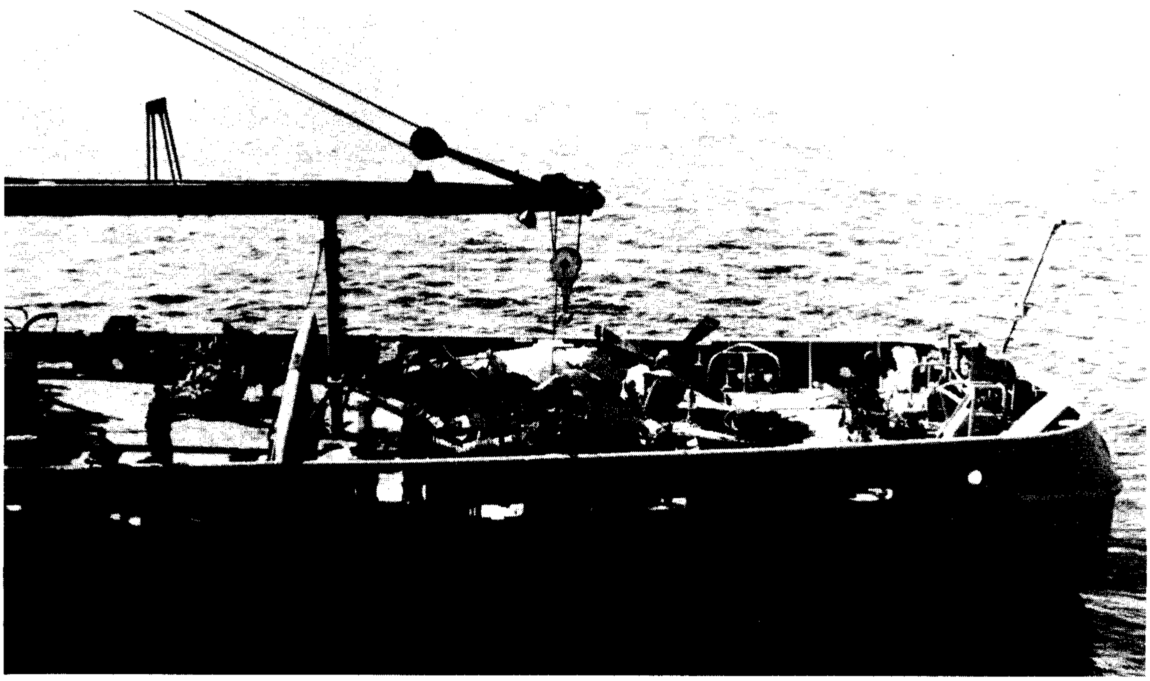
Diver attaching straps to wreckage of engine nacelle for transfer to EDENTON's crane from ALCOA SEAPROBE's mechanical grabber. Nacelle and propeller being hoisted aboard EDENTON with straps attached by divers.

P-3B WRECKAGE BEING RECOVERED BY EDENTON





P-3B fuselage section comes aboard EDENTON.



Fantail of EDENTON with recovered P-3B wreckage.

EDENTON TOOK WRECKAGE TO PORT
FOR ACCIDENT ANALYSIS

The recovery of these last items completed the requirements of the Accident Investigation Board and SALVOPS were terminated. The ALCOA SEAPROBE departed for the Portsmouth Naval Shipyard and the USS EDENTON (ATS-1) departed for Harpswell Neck to offload the recovered aircraft wreckage.

CONCLUSIONS

Performance of the ALCOA SEAPROBE

The ALCOA SEAPROBE proved to be ideal for this type of salvage operation. The recovery of specific items of wreckage from a depth of 570 feet, by a craft held in position without benefit of moor, is truly a unique and outstanding accomplishment. The entire operation, including two days lost due to inclement weather, took only nine days. This prompt and efficient service considerably reduced the cost and effort required with conventional salvage ships and equipment.

The unique features of ALCOA SEAPROBE were a primary reason for the overall success of the salvage effort. The ALCOA SEAPROBE was able to successfully conduct SALVOPS in up to state four seas. The ability to move in any direction as required was instrumental in accurately mapping and photographing the scattered debris. It permitted the visual inspection of the debris as it lay on the bottom, and from this, identification of salvage damage to recovered wreckage. The ability to quickly return to selected pieces of wreckage and to hover in position, without a moor, contributed to the quick and efficient recovery of only those pieces of wreckage selected by the Accident Investigation Board. The variety of tools which could be deployed fulfilled all search and salvage requirements. Moreover, facilities aboard the ALCOA SEAPROBE were adequate to meet all requirements for repair or modification of equipment.

Because of space limitations and rigging problems, the recovery of wreckage through the center well proved impractical. To overcome this, divers went through the center well to attach straps to the wreckage while it was suspended below the ALCOA SEAPROBE. The actual depth at which the straps were attached was dependent upon the sea state, as the action of the waves tended to work items loose from the jaws as they approached the surface. When the straps were connected to a shipboard crane, the grabber jaws opened to release the wreckage, which was then hauled aboard over the side. This method proved satisfactory for all remaining wreckage, once the technique was evolved.

The depth of the water in which the operation took place caused minor difficulties. The water was, actually, too shallow for the most effective operation of the ALCOA SEAPROBE. The motion of the ship caused by maneuvering and the action of the seas made control of the search and recovery pods more difficult. At deeper depths, with more pipe sections lowered, the forces generated by the movement of the ship would be absorbed by the pipe.

Performance of Precision Equipment

Both the D.R. Raydist Navigation System and the Acoustic Ship Positioning System used during the operation proved to be very effective, providing an accuracy of less than 2 feet. Each system worked to complement the other, whereas complete reliance on either would have resulted in lost time.

The side-scan sonar also performed admirably. During search operations, the sonar successfully located the wreckage within a 24-square-mile area in less than one day of actual operation. Side-scan sonar in the search pod provided immediate location of the wreckage after the salvage force arrived on-scene.

Results

In a total of 11 operating days, the missing aircraft was located and all wreckage needed to establish the cause of the accident, the prime objective of the operation, was recovered. Additional valuable data was provided the Accident Investigation Board by photographically recording all wreckage as it originally lay on the bottom. All equipment effectively performed its designed functions, and difficulties that arose were quickly and professionally handled by assigned personnel. The entire operation was extremely successful and clearly displayed the efficiency of the equipment and personnel. The value of the ALCOA SEAPROBE in future operations of this nature was firmly established.

SUMMARY

OF

DOWNED AIRCRAFT

SEARCH AND RECOVERY OPERATIONS

IN 1973

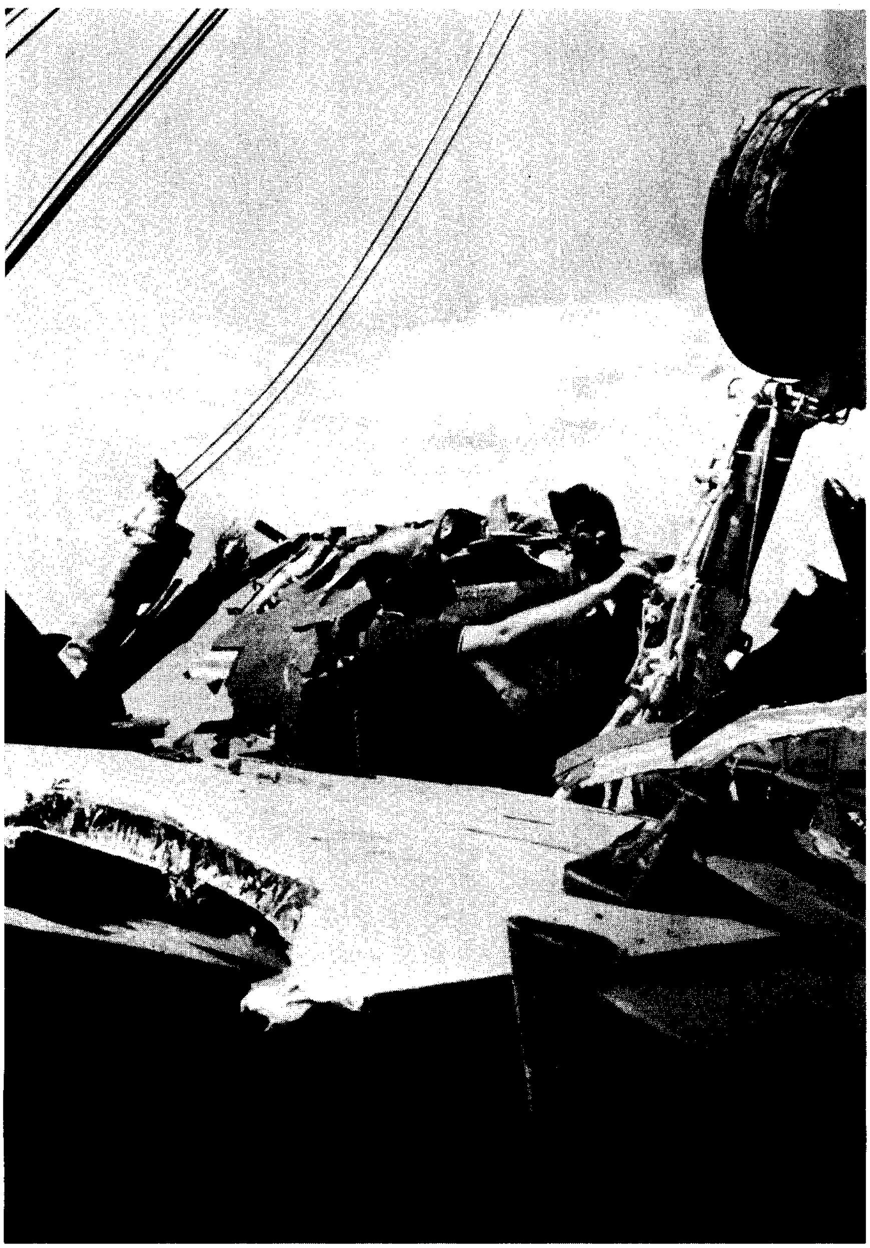
SUMMARY

OF

DOWNED AIRCRAFT

SEARCH AND RECOVERY OPERATIONS

IN 1973



Prompt examination of recovered aircraft wreckage is frequently needed to determine accident causes in a series of aircraft. The technical and operational assistance of SUPSALV is crucial to providing the material evidence when aircraft are lost over water.

ON-SCENE INSPECTION OF RECOVERED AIRCRAFT

SUMMARY OF DOWNED AIRCRAFT SEARCH AND RECOVERY OPERATIONS IN 1973

INTRODUCTION

Determination of the cause of aircraft crashes in most cases is based on recovery of the wreckage, and inspection of the aircraft's critical components. An aircraft that crashes into water, however, often breaks up severely on impact or sinks to great depths, which makes finding and recovery of wreckage, even by sonar and divers, extremely difficult. Often only an oil slick, which may have drifted considerably by the time the first searchers arrived on the scene, provided the only evidence of the crash location.

Because detection and recovery of aircraft wreckage at sea is often difficult, and urgent, the U.S. Navy Office of the Supervisor of Salvage (SUPSALV) is frequently called upon to provide assistance. With its own assets and those of its contractors, SUPSALV possesses the specialized resources, technical expertise and quick response capability necessary to provide the successful aircraft search and recovery operations needed in the marine environment. In some cases, advice and recommendations are given; in others, full-scale, on-site, operational support may be provided.

Each of the following operations is summarized in this article:

OPERATION	DATE OF CRASH
Search and Recovery of U.S. Navy F-4B Aircraft off Mayport, Florida	15 May 1973
Search and Recovery of U.S. Air Force RF-4C Aircraft off Myrtle Beach, South Carolina	7 June 1973
Search and Recovery of U.S. Navy HH-2D Helicopter from Subic Bay, Republic of the Philippines	11 June 1973
Search and Recovery of U.S. Navy TA-4J Aircraft off Pensacola, Florida	17 July 1973
Search and Recovery of U.S. Navy A-7E Aircraft off Virginia Beach, Virginia	14 Dec 1973

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ON-SCENE INSPECTION OF RECOVERED AIRCRAFT

SEARCH AND RECOVERY OF U.S. NAVY F-4B AIRCRAFT OFF MAYPORT, FLORIDA

Date:	15 Mary 1973
Location:	3 miles northeast of Naval Air Station, Mayport, Florida
Condition:	Wreckage in 31 feet of water
Task:	Search and Recovery

Background

Ten minutes after taking off from N.A.S. Mayport, Florida, on the afternoon of 15 May 1973, a U.S. Navy F-4B Phantom aircraft suffered a complete failure of electrical power. The aircraft's wind-driven, emergency ram-air turbine (RAT) generator successfully deployed into the slipstream after the electrical casualty occurred, but failed to operate. Although the aircraft remained without electrical power, it was still airworthy. Since the aircraft was heavy with fuel, the pilot elected to stay airborne and burn off fuel before attempting to land. However, electrical failure prevented the normal transfer of fuel from the external and wing tanks, and after about 50 minutes, the engines flamed out. The pilot and crewman ejected safely and were rescued by small craft in the area. The plane crashed into the sea approximately 3 miles northeast of the air station.

The crewman of the aircraft observed the crash from his position in the water and was able to report its relative bearing and range. Also, observers from a nearby fishing pier and a parking lot reported relative bearings and ranges. More exact bearings to the point of impact were recorded and reported by the commanding officer of the Coast Guard Cutter WHITE SUMAC and by observers from the air station tower.

This information, plus the sighting of a distinct oil slick, enabled air station authorities to fix a position of the crash, and place a marker buoy within 2 hours. Although the first attempt at placing the buoy by helicopter failed when the buoy's concrete sinker shattered, a second buoy was successfully placed by tug a short time later. The helicopter guided the

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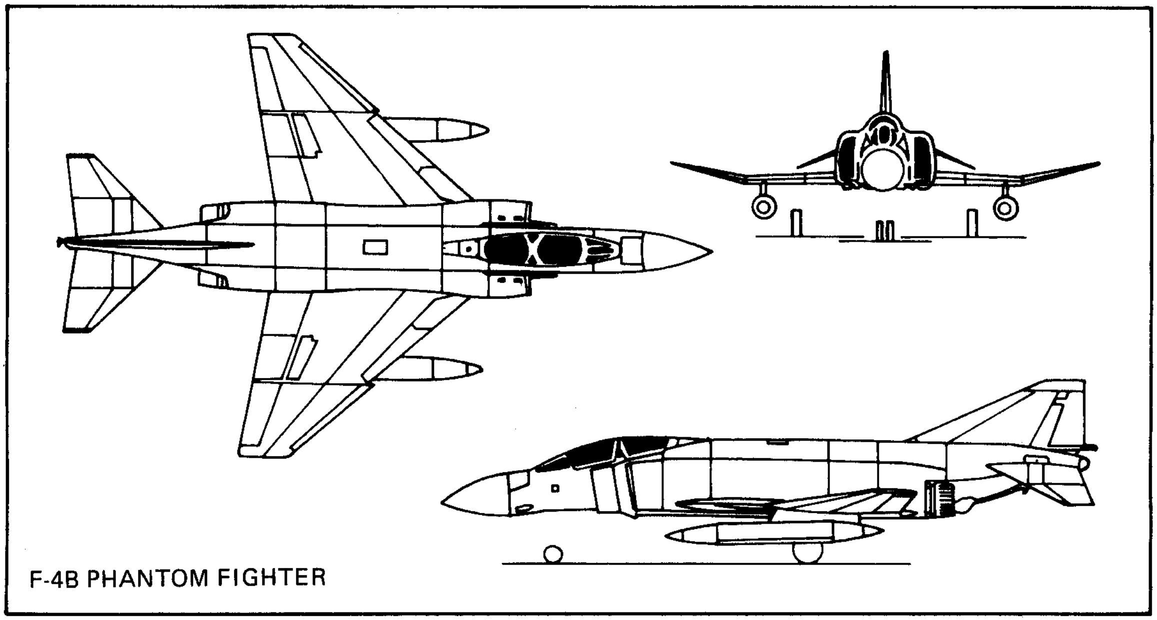
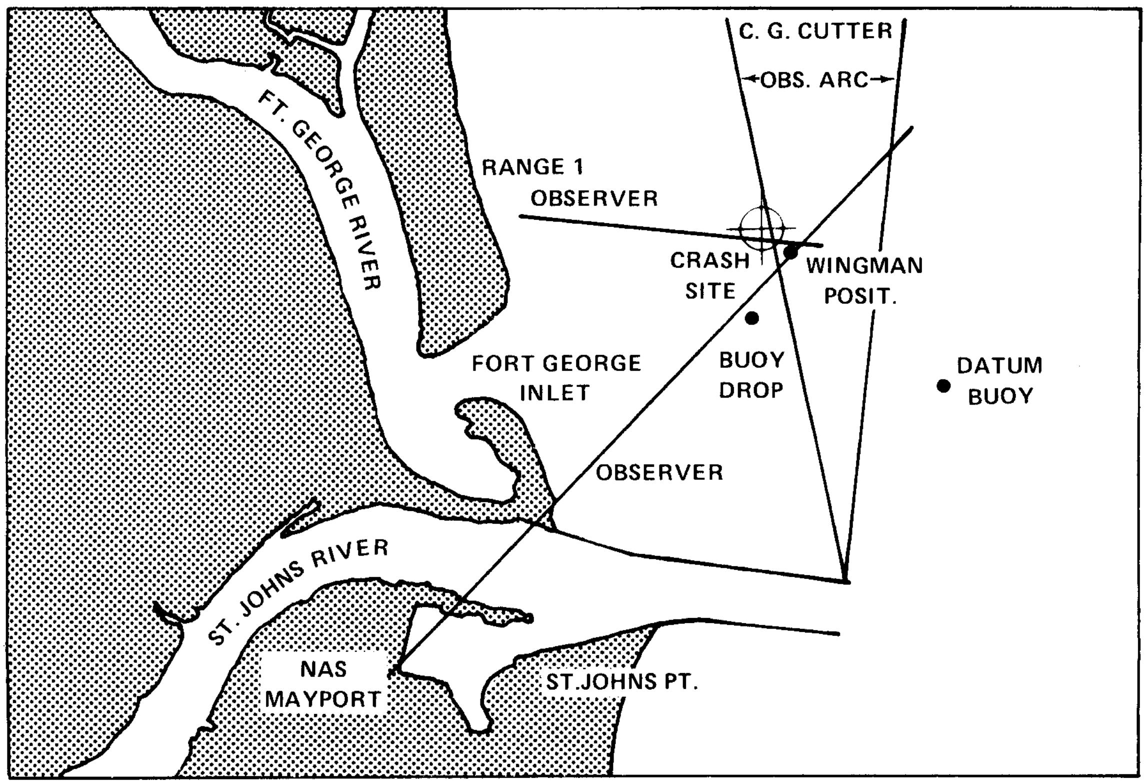




LOCATION OF NAVY F-4B CRASH
OFF NAS MAYPORT, FLORIDA

tug to the oil slick, which was not visible to the crew aboard the tug. Water depth at the designated crash site was approximately 30 feet.

Planning the Search Effort

The Office of the Supervisor of Salvage (SUPSALV), U.S. Navy, was notified of the crash on 16 May. After investigations of the sea floor by local Navy divers turned up no trace of the jet fighter wreckage, SUPSALV received an official request for assistance on the evening of 17 May.

A SUPSALV representative supervised several attempts to locate the aircraft on 17 May by grappling in an area about 1 mile northwest of the marker buoy. No aircraft wreckage was located, however, and the grappling attempts were terminated. The searchers had to take into account the effects of a flood tide and 10-knot winds on the oil slick in the 3 1/2 hours that intervened between the time of crash and the placement of the second marker buoy. Therefore, despite the seemingly precise determination of the crash site earlier, wreckage detection was not expected to be necessarily rapid or easy.

The search team concluded that side-scan sonar should be used. On the evening of 17 May, SUPSALV tasked Ocean Search, Inc., and its subcontractor, Seaward, Inc., to provide the necessary equipment and personnel for the search operation.

The Seaward search project manager arrived in Jacksonville on the afternoon of 18 May, reviewed available data on the crash location, and selected initial search area and navigation stations sites. By early evening, all search and navigation equipment and additional search personnel had arrived at Mayport.

The primary tool for search was the EG&G dual side-scan sonar. This system is comprised of two basic units. A towed streamlined "fish" component contains two sonar transducers, and a shipboard control and recorder unit converts reflected sound signals into a graphic record of the ocean bottom. The sonar may be set at several range readings. For this operation a recorder range of 300 feet on either side of the fish track was selected.

Positioning of the search vessel was accomplished using a Cubic Autotape precision electronic navigation system. The system consists of two shore stations, which continuously relay range readouts to a digital display unit on the search boat. The system has useful over-water range of over 15 miles. For this operation, the shore stations were established at St. Johns Point Lighthouse and the Little Talbot State Park fishing pier, 2.7 miles and 1.2 miles, respectively, from the suspected crash location.

Conduct of Search Operations

Following installation of the side-scan sonar on the search boat (a naval station LCM), and the setting up of the navigation ranges ashore, the search team got under way on the morning of 19 May for the crash area and commenced sonar scanning operations for the F-4 aircraft wreckage.

The search team began sonar scanning operations in the vicinity of the marker buoy dropped by the tug. When no significant contacts were recorded in this area, the search team proceeded to the approximate site of the buoy dropped by helicopter shortly after the crash. However, this area too, yielded no trace of the wreckage.

The search area was then expanded, and at 1530 a solid contact was received. The search boat made several additional sonar passes above the suspected wreckage to better delineate the contact. The sonar picture revealed wreckage positioned along a north-south axis, about 100 feet by 50 feet in size. At 1500, the search team dropped two buoys to mark the contact. Divers then went down to investigate. By nightfall, after completing several dives, the divers had confirmed that the debris was, in fact, the wreckage of an F-4 aircraft. The divers recovered a small piece of wreckage before the search team halted operations and returned to Mayport for the night.

Planning the Recovery Operation

The search team returned aboard the LCM to the crash site on the following morning, 20 May, to further investigate the wreckage. After confirming that all pieces of the aircraft were confined to the area marked on the previous day, the search team suspended operations. Then, as the search team demobilized its equipment and personnel, the salvage ship USS ESCAPE (ARS-6) received orders to provide Naval Station, Mayport, with diver services, bottom survey, and salvage assistance for the upcoming recovery operation.

While the ESCAPE made preparations for getting under way on 21 May, her commanding officer who was designated On-Scene Commander, visited the wreckage site. He also met with a representative from the Office of the Supervisor of Salvage (SUPSALV), an observer for the Naval Safety Center, and two representatives from the McDonnell Douglas Aircraft Corporation. It was decided that the ESCAPE would, upon arrival, make a 2-point moor above the wreckage in order to be able to recover the aircraft wreckage, while a large harbor tug (YTB) from the naval station would be brought in and utilized as a diving platform. The SUPSALV representative would remain on-scene and provide any necessary technical advice during the recovery.

The Naval Safety Center observer was interested in the recovery and inspection of the aircraft's emergency ram-air turbine that had deployed but failed to operate. The McDonnell Douglas representatives were on hand to assist in the identification of the wreckage, and determine the area of highest probability of locating the turbine generator sought by the Safety Center. For these purposes, the recovery team requested use of an Underwater Damage Assessment Television System (UDATS) from the USS YOSEMITE (AD-19).

Conduct of Recovery Operations

USS ESCAPE arrived at the wreckage site on the morning of 22 May and made the 2-point moor. The salvors immediately recovered the aircraft's tail section and after fuselage, which were previously determined to be the largest intact pieces of wreckage. ESCAPE divers then laid a jackstay for re-survey of the bottom and to buoy off the impact area.

The survey using the jackstay revealed the presence of wreckage scattered over a 2,000-square-yard area. Bottom conditions were of soft sand and mud, and much of the wreckage had been partially buried on impact. Water depth was 31 feet. The ESCAPE proceeded to recover selected wreckage located by the divers until 1900 hours, when operations were secured for the night. The YTB returned to Mayport, while the ESCAPE remained on-scene.

The next day, 23 May, the ESCAPE divers continued their search for the critical components sought by the Naval Safety Center. The recovery team used cargo handling nets to hoist large amounts of small, badly broken wreckage aboard the ESCAPE; but by early evening, when the ESCAPE had to withdraw from the operation to fulfill other operational commitments, the ram-air turbine generator was still not recovered. The Naval Station YTB therefore returned to the scene on the following morning to resume the diving and recovery operation. Five ESCAPE divers and a salvage officer remained with the tug and continued to provide invaluable support to the operation.

The UDATS system, previously ordered from YOSEMITE, was installed aboard the YTB ready for use during the day's operations on 24 May, but was not used due to the recall of the McDonnell Douglas representatives. Making a 2-point moor as the ESCAPE had, the YTB carried on the effort, recovering more of the aircraft wreckage, and a day later the recovery team successfully located and recovered the elusive ram-air turbine generator, plus other critical components. Thereupon, on the recommendation of the SUPSALV and Naval Safety Center representatives, operations were secured.

Conclusions

Once the F-4's wreckage had been located on the sea bottom of Mayport, the recovery operations consisted of the simple but tedious task of bringing portions of wreckage to the surface. ESCAPE recovered the larger, heavier portions of wreckage using a cargo net, before it had to depart the scene. Thereafter the Naval Station YTB completed the task with full success, utilizing a metal basket, swung from davits, to recover the remaining small debris. Ultimately, the basket method provided to be a simpler, better expedient for small debris than the cargo net method needed for larger pieces.

There were no significant difficulties encountered during operations, except for a minor engine breakdown on the LCM search boat during the first day of search operations on 19 May. The problem was corrected within an hour. No ecological problems developed, either. The salvage and material support provided by Naval Station, Mayport was excellent, enabling the salvors to accomplish rapid and successful recovery of the F-4's components required to determine the cause of the crash.

SEARCH AND RECOVERY OF U.S. AIR FORCE RF-4C AIRCRAFT OFF MYRTLE BEACH, SOUTH CAROLINA

Date:	7 June 1973
Location:	20 miles east of Myrtle Beach, South Carolina
Condition:	Wreckage in 60 feet of water
Task:	Search and Recovery

Background

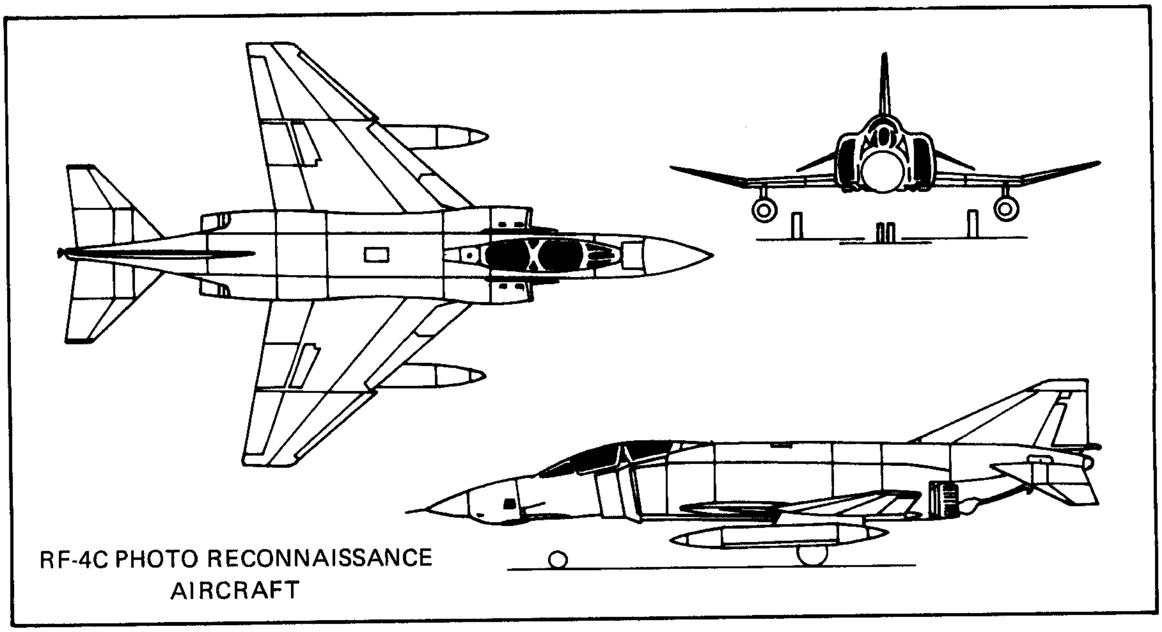
A U.S. Air Force RF-4C aircraft from Shaw Air Force Base near Sumter, South Carolina, crashed into the Atlantic Ocean 25 miles east of Myrtle Beach at approximately 1150 on 7 June 1973. A search and rescue helicopter out of Myrtle Beach AFB was quickly dispatched to the scene, guided by a position report from another aircraft in the vicinity. Within an hour, the helicopter had rescued both crewmen of the downed jet fighter from a circular oil slick and debris area approximately 200 yards in diameter.

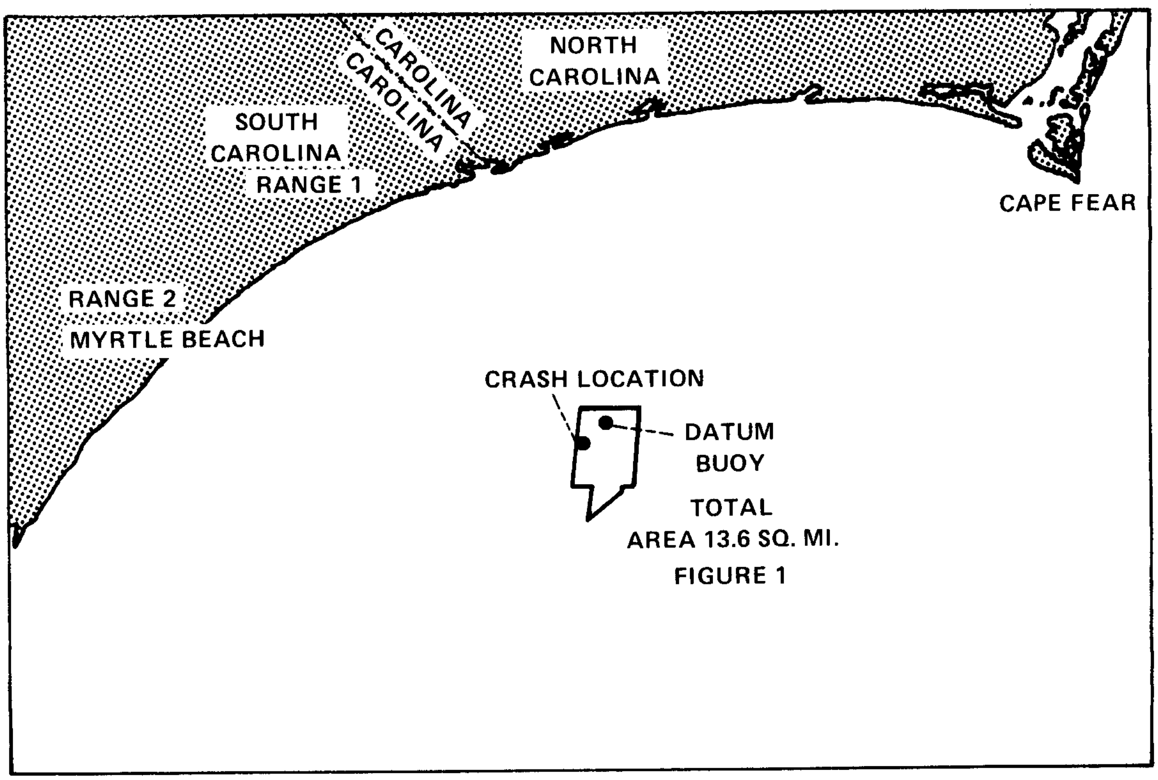
Later in the day, the helicopter returned to the oil slick, which by then had spread in a northerly direction for about 1 mile from the effects of wind from the southeast at 10 to 15 knots. Most of the floating debris was concentrated at the head, or northern, portion of the slick. The helicopter dropped an orange life vest with a steel sinker at the southern end of the slick, to indicate its probable origin. The Coast Guard subsequently planted a more substantial buoy adjacent to the vest.

Assembling the Search Force

The Air Force requested search and recovery assistance from the U.S. Navy Office of the Supervisor of Salvage (SUPSALV) on the day of the crash. SUPSALV immediately initiated mobilization of search equipment and personnel through SUPSALV's contractor, Ocean Search Inc., and its subcontractor, Seaward, Inc. EG&G side-scan sonar equipment, a Cubic Autotape precision navigation system, and appropriate technicians were deployed to the scene by 8 June, within a day of the crash.

Also on 8 June, the Air Force Accident Investigation Board president, an Air Force Safety Officer, a SUPSALV representative, a Seaward representative and other interested





**LOCATION OF U.S.A.F. RF-4C CRASH
OFF MYRTLE BEACH, SOUTH CAROLINA**

parties, met and reviewed all available information about the crash case. By early afternoon of the next day, shore range sites for the precision navigation system were selected and set up at the Ocean Forest Apartments just north of Myrtle Beach, and the Cabana Terrace Motel further north near Cherry Grove Inlet. Also, interviews were conducted to obtain additional crash location data. The acquisition of the 60-foot charter boat M/B BONITO, to serve as a diving and support platform, allowed the search team to get under way for the crash site at first light the next morning, 10 June.

Conduct of Search Operations

With search personnel and equipment aboard, the BONITO arrived at the marker buoy at 0930 on 10 June. The first day's efforts, however, proved unsuccessful as a result of equipment problems in three crucial areas. The precision navigation receiver-interrogator mounted aboard the BONITO would not function because of interference from heavy squalls in the area. The EG&G side-scan sonar became inoperable for 90 minutes following a blowout of the 700-volt line sheathing. Later in the day, the BONITO's starboard engine malfunctioned, forcing the search team to return to port for repairs. The search team did conduct a random search of the area around the marker buoy despite these equipment problems. However, the search revealed no trace of the aircraft wreckage.

During the second day of search, on 11 June, the BONITO towed the side-scan sonar successfully over an area 1/2 mile wide by 2-1/2 miles long. But, again, after 9-1/2 hours of searching, no trace of the aircraft wreckage was detected. The precision navigation system continued to malfunction. Only Navigation Range 2 was received reliably by the BONITO; Range 1 was received only intermittently. Then, on 12 June, increasingly adverse weather conditions dealt another blow to the search operations. BONITO's antenna mast collapsed under the stresses created by the rough seas, again putting the navigation system out of commission. The BONITO returned to port for replacement of her antenna but was back on the scene to resume search operations by early evening.

Although the search team conducted operations throughout the night, effectiveness was diminished by the worsening weather. The vessel's pitch and roll deteriorated the sonar record quality and the new navigation antenna, again, threatened to snap. The search team, therefore, at dawn, decided to head for port, avoiding antenna damage from a cross-sea heading by proceeding with the seas, northward, to Little River and then to port via the Intracoastal Waterway.

Once back in port at 1000, the search team rerigged the shore navigation masts, seeking to improve performance reliability. The antenna height was raised from 150 feet to 160 feet at Range 2, and from 70 feet to 80 feet at Range 1. These measures however, increased reception aboard the BONITO only marginally as she swept the search area to the east and north of the marker buoy for 9 hours on the following day, 14 June. The search team decided that because of the BONITO's antenna height above water of only 50 feet, the boat's overall instability, and its restricted logistic capability, another search vessel should be acquired.

USS PAIUTE Replaces M/B BONITO

The USS PAIUTE (ATF-159) is a Fleet Ocean Tug of World War II vintage that measures 205 feet in length and 39 feet abeam, and is fitted with a lift boom, powerful pumps, and other salvage equipment. With a mast height of 80 feet, the vessel was a substantially more suitable platform for the navigation receiver-interrogator than the BONITO. The tug's superior stability also made it preferable to the BONITO in the heavy seas that were being experienced off shore. Finally, the choice of the tug was prompted, to some degree, by the opportunity to give the PAIUTE the chance to become the first ATF to effect a complete recovery of downed aircraft wreckage in recent years.

Search Operations Resume

The PAIUTE departed Mayport, Florida, on 14 June and arrived at the search area to rendezvous with the BONITO at first light on 15 June. The C.O. of PAIUTE became On-Scene Commander and received all personnel and equipment from the BONITO during the morning, including the navigation system's receiver-interrogator, which was installed atop the vessel's forward mast. By noon, with the PAIUTE's crew briefed on the operation and with all equipment operational, the ATF entered the search area east of the marker buoy, and resumed the sonar search. Operations continued into the night over a 2-square-mile area until 2300. Around-the-clock operations were not possible due to sonar and navigation system operator fatigue.

Over the next three days, excellent weather conditions prevailed and the PAIUTE continued its search in areas to the southwest, west, northwest and northeast of the marker buoy. However, no significant contacts were detected. Although one strong contact was received on 16 June, diver investigations revealed the contact to be an unusual outcrop of rock covered with sea life, and no evidence of aircraft wreckage was sighted. The divers reported excellent underwater visibility, ranging from 10 to 30 feet, and a hard sand bottom.

Efforts were intensified on 19 June as a result of a visit on 18 June by the Air Force Accident Investigation Board president to the PAIUTE to inform the search team of the high priority which had been placed on recovery of the wreckage. This urgency was due to similar, unexplained losses of Air Force F-4 aircraft in recent months. As a result, a second sonar operator was flown in so that around-the-clock operations could be conducted. Also, arrangements were made with Myrtle Beach AFB to have the helicopter that rescued the F-4 crewman fly over the search area again and seek to confirm the crash buoy position which the PAIUTE was using as a datum point.

The helicopter arrived over the site at 1400, 19 June, as the search team entered its eighth hour of unsuccessful search efforts already that day; on the helicopter pilot's recommendation, the search team shifted operations further to the west of the marker buoy. The recommendation proved sound. Approximately 7 hours later, at 2100, the sonar recorded a very strong contact at LAT 33° 37.2'N, LONG 78° 23.6'W. The PAIUTE made five sonar runs on the contact to define its configuration and position, and then dropped a marker buoy. It was nearly midnight when the vessel anchored for the night. At first light, divers would enter the water to investigate the contact.

Conduct of Recovery Operations

Investigation by PAIUTE's divers on the morning of 20 June confirmed that the contact was, in fact, aircraft wreckage. Smaller pieces (a camera and an angle of attack indicator) were then brought to the surface and positively identified as part of an F-4 aircraft by an Air Force maintenance officer aboard the PAIUTE.

The aircraft had apparently entered the water at a relatively low rate of speed, as the wreckage was confined to a 2500-square-foot area and was in just five major pieces: tail section, both wings, engines (one with afterburner still attached), and fuselage. The divers reported the water depth at 55 to 60 feet; bottom visibility was excellent.

Recovery operations commenced later in the morning. Divers attached a wire strap to one of the wings, and by noon, this first large section was lifted and placed on deck by the PAIUTE's after boom. By the end of the day's operations, the aircraft's tail section, other wing, lower fuselage section with afterburners, both engines and nose landing gear had been recovered. Of the major pieces of wreckage, only the forward section of the fuselage remained unrecovered.

The second day of recovery operations began with the retrieval of the last major piece of wreckage, the forward fuselage section. The PAIUTE then turned its attention to the more selective recovery of components which would be useful to the Accident Investigation Board — whose president, along with a technical representative from the aircraft manufacturer, again arrived on board the PAIUTE. These components included hydraulic pumps, panels and activators, stabilizer activator, flight control linkage, fuel valves and various electrical instrumentation. Since these were generally too small to recover individually, they were gathered and placed into cargo nets by the divers, then lifted aboard the ship. By nightfall approximately 95 percent of the aircraft had been salvaged. Only miscellaneous pieces of the aircraft's skin, which were deemed unnecessary for Accident Investigation Board purposes, remained unrecovered. The PAIUTE, accordingly, terminated operations and proceeded to the Charleston, South Carolina, Naval Station to offload the wreckage.

Conclusions

The conduct of both the search and recovery phases of the operation showed good judgement in overcoming initial operating difficulties. Problems with the navigation range reception aboard the charter boat were rectified as soon as operations were transferred to the USS PAIUTE, whose approximately 30 feet additional mast height provided for adequate navigation system transmission range. Detection of the wreckage by the side-scan sonar did not occur until the tenth day of search operations. The rough sea conditions during the early part of the search had evidently moved the marker buoy as far as 1/2 mile to the east of its original location. The search and rescue helicopter's fly-over on 19 June effectively guided the search team much closer to the wreckage. Detection was accomplished later that same day.

It was not enough to scan a given bottom sector just once. Bottom topography, particularly in the vicinity of the buoy, was quite irregular and unpredictable. Portions of the area therefore had to be scanned twice, at right angles to each other, to avoid missing potential targets.

The PAIUTE proved to be an outstanding salvage platform for the operation. The tug's after boom easily recovered even the largest piece of the aircraft wreckage. A full 80 percent of the wreckage was recovered on the first day of the two-day effort. The performance of the PAIUTE's deck crew and four divers was exceptional. Although fleet ocean tugs are assigned to aircraft salvage operations only infrequently, the result of this recovery indicated that ATF's have both the equipment and personnel to accomplish such operations with great efficiency.

SEARCH AND RECOVERY FOR U.S. NAVY HH-2D HELICOPTER FROM SUBIC BAY, REPUBLIC OF THE PHILIPPINES

Date:	11 June 1973
Location:	Subic Bay, 1 1/2 miles southeast of Sueste Point
Condition:	Helicopter in 192 feet of water
Task:	Search and Recovery

Background

While on a routine mission in the Republic of the Philippines on 11 June 1973, a U.S. Navy HH-2D helicopter from the USNS CHAUVENET (T-AGS29) experienced an engine failure and crash landed on a beach. The amphibious transport dock USS DULUTH (LPD-6) retrieved the helicopter and proceeded for the Cubi Point Naval Air Station (NAS) at Subic Bay, where the helicopter would be disassembled and examined to determine the cause of the crash.

When the DULUTH reached the mouth of Subic Bay on 14 June, the damaged helicopter was lifted from her deck by a CH-53 helicopter, for transfer to NAS Cubi Point. During transport over the water, however, the CH-53 helicopter's lifting pendant failed. The damaged HH-2D helicopter dropped into the bay from a 150-foot altitude at a point approximately 1 1/2 miles south-southeast of Sueste Point and sank 192 feet to the bottom.

Following the loss of the helicopter, repeated attempts were made to locate it by means of sonar, diving, and grappling techniques. These operations were conducted by local forces, including the Subic Bay Naval Ship Repair Facility, the salvage and rescue ship USS BEAUFORT (ATS-2) and the ocean minesweeper USS LEADER (MSO-490). The helicopter, however, could not be found. The bottom was extremely muddy and recent rains further reduced bottom visibility. Moreover, the UDATS (Underwater Damage Assessment Television System) equipment brought in for the search did not operate properly. Finally, the hard hat divers occasionally experienced narcosis because of the depths, making diving operations hazardous and unproductive.

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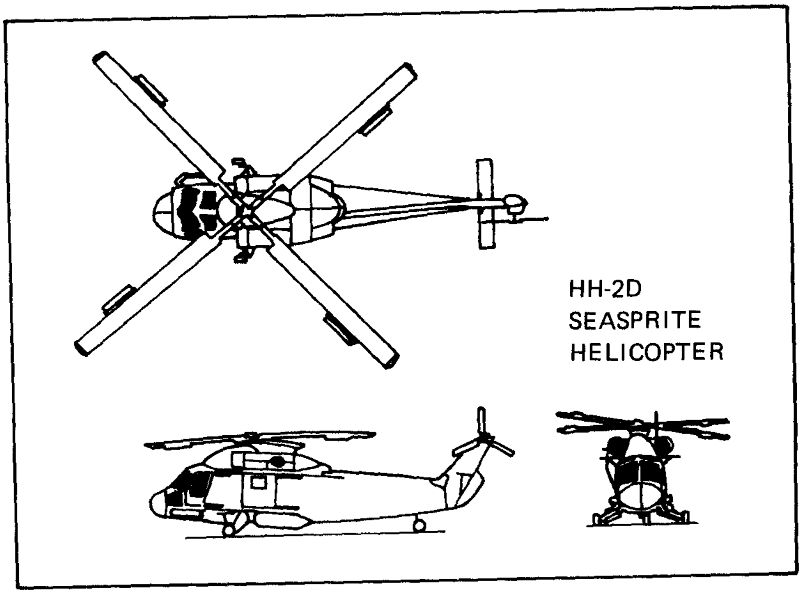
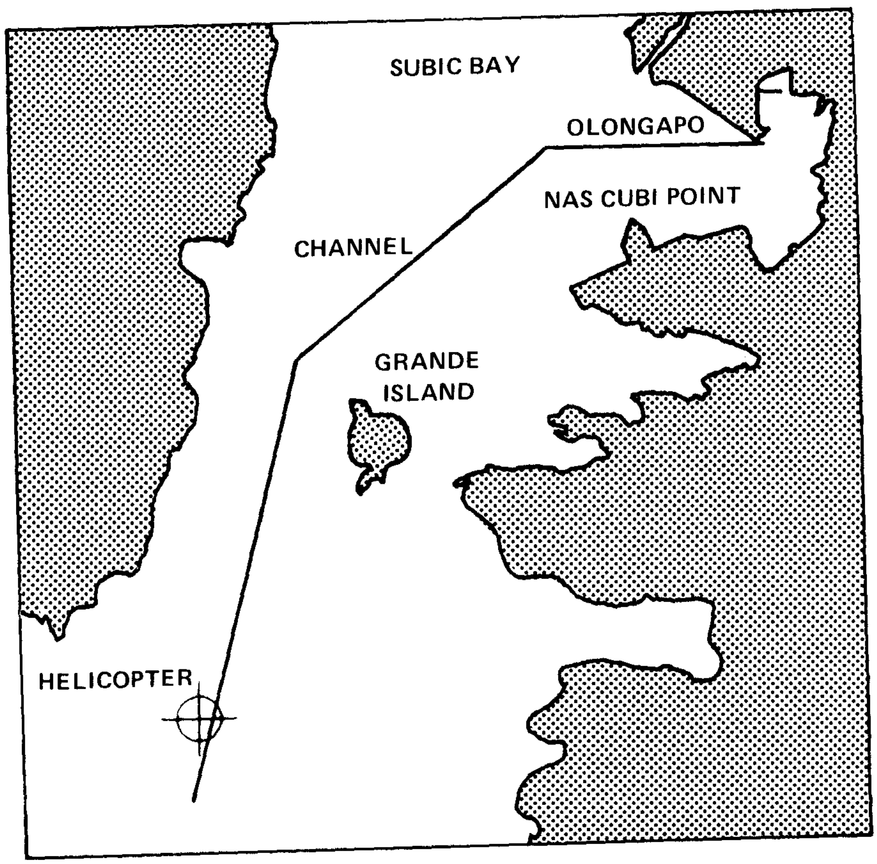




LOCATION OF NAVY HH-2D HELICOPTER LOST IN SUBIC BAY CHANNEL

SUPSALV Assistance

Due to the difficulty and dangers being encountered by local forces, the U.S. Navy Office of the Supervisor of Salvage (SUPSALV) was asked on 19 June to provide search and recovery assistance. Although the BEAUFORT had succeeded in snagging the helicopter earlier in the day, the line parted and relocation was unsuccessful. Acquiring side-scan sonar and a precision navigation system through SUPSALV was believed to be the most expedient and prudent approach to the problem of detecting the helicopter.

From 20 to 23 June, arrangements were made to assemble and transport the search team and necessary equipment to the Philippines. SUPSALV contacted its search contractor, Seaward, Inc., for an EG&G side-scan sonar system and a Cubic Autotape precision navigation system. By 22 June, all search equipment and personnel had assembled in San Francisco for flight to Manila. Upon its arrival in Manila, the search team met with the SUPSALV representative already there, and proceeded to NAS Cubi Point via a U.S. Navy aircraft. By noon, 24 June, the search team had met with the Subic Bay salvage officer, and had set up and checked out their search equipment aboard the BEAUFORT. Shore ranges for the navigation system were erected the next day on Grande Island at the center of the bay, and at Sueste Point, 2.6 and 1.5 miles respectively from the reported crash location.

Conduct of Search Operations

The search team got under way for the crash site aboard the BEAUFORT at 0920 on 25 June. By late morning, the sonar was streamed, ready for scanning. The sonar's tow cable however was faulty, requiring the search team to recover the cable and make repairs.

My mid-afternoon, the cable was repaired and the sonar again lowered away. At 1416, within 12 minutes of the start of scanning operations, a strong target believed to be the helicopter was recorded. The BEAUFORT made several sonar runs over the target to pinpoint its location and define its shape.

The next day, after the BEAUFORT was placed in a 2-point moor, a diver's stage was lowered to the bottom approximately 25 feet from where the helicopter's position was determined to be. A diver was then sent down, but returned reporting that he was unable to locate the helicopter. Meanwhile, winds and currents caused the ship's position to shift about 120 feet to port. The BEAUFORT set an additional anchor off the starboard quarter to strengthen the mooring, but by then it was necessary to secure diver search operations for the day.

The next day the BEAUFORT was maneuvered closer to a position above the helicopter using the ship's bow thruster and pusher boats. A hard hat diver was sent down, this time with hand-held sonar, to locate the helicopter relative to the diving stage. Once on the bottom, however, the diver became disoriented and had to return to the surface. Later in the day, a diver was again lowered to the stage. The stage was now resting directly on top of the helicopter, which was upside down in the mud. The diver shackled a line to it but was unable to locate the lifting strap or bail. After the diver was returned to the surface, the BEAUFORT took a strain on the line. This first attempt to lift the helicopter, however, failed when the attachment point broke loose.

Operations were ready to resume the next day, 28 June, when the last diver began experiencing pain. It was decided to give the diver recompression treatment for the bends, and to place the search team in a standby status during a 48-hour treatment period. Meanwhile, the search team requested authorization from the Chief of Naval Operations for divers to use the Kirby-Morgan Bandmask (KMB-8) in place of the hard hat equipment. CNO permission was necessary since the helicopter was beyond the depth for which working dives with the KMB-8 system were authorized.

Conduct of Recovery Operations

Operations resumed on 1 July. The BEAUFORT was joined at the site by the USS DELIVER (ARS-23), which supplied additional divers. Authorization to use the KMB-8 had been received the night before, and all divers were well rested and in good condition after the standby period. The BEAUFORT first had to be repositioned over the crash site, since despite its moor, winds from thundersqualls during the standby period had pushed the ship 300 feet from the moor position over the helicopter.

At noon the ship was in position and a diver was sent down to the diving stage to accomplish a hook-up of a nylon lift line from the BEAUFORT to the helicopter. However, he was forced to return to the surface because his hose was too short to allow him to reach the helicopter from the stage. A second diver was successful in attaching the nylon line to the helicopter's landing gear strut, but the extremely limited bottom time at the 192-foot depth prevented him from completing the second attachment point at the rotor hub. A third diver had to be recovered when he could not equalize ear/sinus pressure, and a fourth diver ran out of submergence-at-depth-time before he could complete the attachment around the hub. Finally, a fifth diver successfully accomplished the hook-up of a lift wire, returning to the surface at 1700.

The BEAUFORT began lifting with its after boom within 10 minutes, and by 1720, the helicopter neared the surface. While the helicopter was suspended at 30 feet, divers attached a sling and crane hook to the lifting bail on the rotor hub. The BEAUFORT then hoisted the helicopter on deck. BEAUFORT crewmen immediately washed the port engine with fresh water and ran water continually through the jet intake as the ship returned to port. Operations were secured at 2100, after the ship docked at NAS Cubi Point and offloaded the helicopter.

Conclusions

The substantial depth, poor visibility and significant currents at the casualty site made the diver's search and recovery work difficult and dangerous. Yet, serious injuries were avoided. Although there was incidence of narcosis and the bends, these problems were overcome by decompression and by the substitution of KMB-8 gear for the Mark V deep sea rig. A diving medical officer was on board the BEAUFORT at all times to insure the safety of the divers.

Recovery of the helicopter and its T-58 engine was deemed essential since the same type engine had failed in two other recent helicopter casualties in the area. The salvage of this HH-2D from the depths of Subic Bay allowed naval air safety officials to determine the cause of the engine failure and to correct the problem, thereby preventing possible future losses of aircraft and lives.

SEARCH AND RECOVERY OF U.S. NAVY TA-4J AIRCRAFT OFF PENSACOLA, FLORIDA

Date:	17 July 1973
Location:	60 miles southwest of Pensacola, Florida
Condition:	Wreckage in 134 feet of water
Task:	Search and Recovery

Background

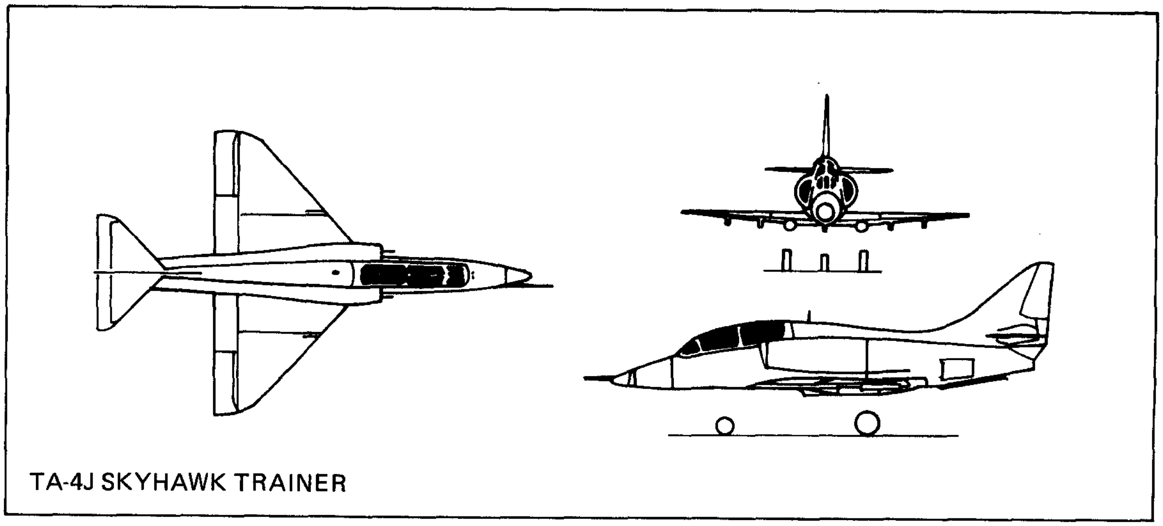
On 17 July 1973, a U.S. Navy TA-4J aircraft attached to Training Squadron 7, Naval Air Station, Meridian, Mississippi, crashed shortly after takeoff from the USS LEXINGTON (CVT-16), and sank in 134 feet of water in the Gulf of Mexico 60 miles southwest of Pensacola, Florida.

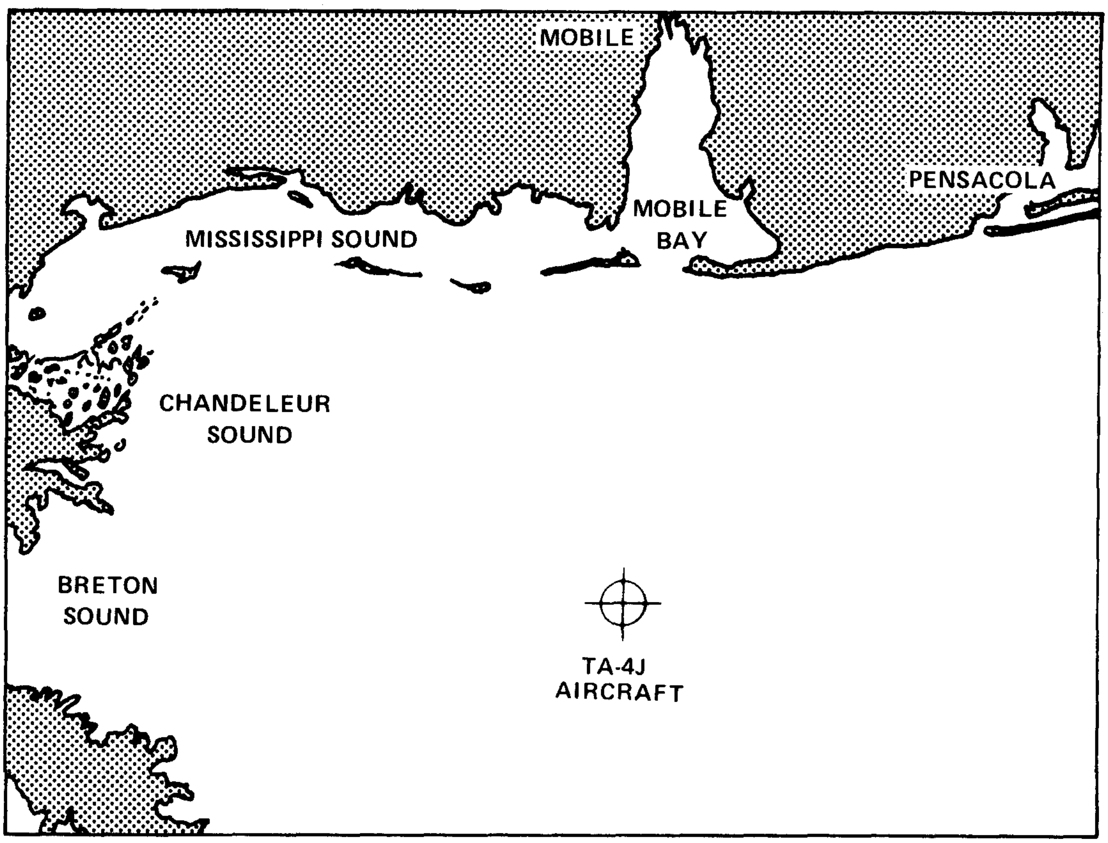
Although the jet fighter was catapulted properly from the flight deck, the engine lost power once the aircraft was over the water. It crashed about 600 yards from the carrier and sank nose first, after remaining afloat for approximately 45 seconds. The LEXINGTON immediately rescued the pilot, who had ejected safely just prior to the crash. The carrier then inspected the crash site, finding a 2-foot-long nose cone and a wing tank still afloat, and recorded a LORAN A fix at LAT 29° 32.6'N, LONG 88° 08.2'W. The carrier navigator had also taken a radar position fix at the time of the crash.

Planning and Search and Recovery Effort

The Supervisor of Salvage (SUPSALV) received a request for assistance in locating and recovering the TA-4J's wreckage from the Chief of Naval Air Training on 19 July. The next day, representatives from SUPSALV and from Seaward, Inc., a contract salvor, were dispatched to the Pensacola Naval Air Station (NAS) to gather data from which to establish a search area and to mobilize necessary search equipment.

Following an early afternoon meeting with the NAS Pensacola Port Services Officer and the NAS Meridian Senior Investigator, the SUPSALV representatives contacted





LOCATION OF NAVY TA-4J CRASH OFF PENSACOLA, FLORIDA

Hydrosurveys, Inc., for use of an EG&G side-scan sonar system. John E. Chance & Associates also were contacted for use of a LORAC navigation system and for the 100-foot vessel M/V OCEAN SURVEYOR, which would be used as the search platform. Later in the day, a meeting was also held with the LEXINGTON's navigator and one of his quartermasters, who provided the SUPSALV representatives with navigational and meteorological data relevant to the crash. Also that day, an A-4 aircraft similar to the one that crashed was inspected by the salvors to determine best points of lift under various conditions. Arrangements were also made for the NAS Meridian Senior Investigator to be aboard the recovery ship at the time of recovery.

The next day, 21 July, the SUPSALV and Seaward representatives departed for Venice, Louisiana, where the OCEAN SURVEYOR was located, to organize the mobilization of equipment. That night the LORAC and side-scan sonar operators arrived on board with their equipment and then began checkout of their systems. The OCEAN SURVEYOR got under way for the search area at 2250, in calm seas with light winds.

Conduct of Search Operations

The search team arrived on-scene at 0450 the next day, 22 July, and dropped a buoy to serve as a reference point for the LORAC precision navigation system. LORAC is a hyperbolic system using phase comparison of beat frequencies to measure differences of distance from transmitters. Two LORAC chains, each consisting of a center station and two reference stations, provide two lines of position. Since the system requires recalibration of the shipboard readout whenever power or lane count is lost, the search team's first task was the placing of a tautly-moored reference buoy in the search area to facilitate recalibration as necessary.

With the calibration of the LORAC system and the placing of the reference buoy accomplished later in the morning, the search team deployed the side-scan sonar and began sweeping the area. Sonar scanning continued for the next 8 1/2 hours with no trace of the wreckage detected. The search team halted operations at 1945 and anchored at the buoy for the night, after interference from nighttime radio signals, or "sky waves," began to affect LORAC reception.

The start of search operations, next morning, was delayed until workmen completed repairs to a LORAC station struck by lightning during the night; but, by mid-morning, the

LORAC was back on the air. The search team calibrated the equipment and continued sonar operations until 1950 when sky waves again disrupted LORAC reception. The OCEAN SURVEYOR then headed for Pascagoula, Mississippi, Coast Guard Station to pick up a technical representative and to disembark another.

The OCEAN SURVEYOR was again under way for the search area during the early morning hours of 24 July. During 12 hours of steady searching only one possible contact was detected, and this later proved negative under closer inspection. As the searchers secured from operations for the evening, they observed that the reference buoy had moved several miles off-station. An inspection of the buoy revealed that the anchor attachment cable had chafed through, allowing the buoy to drift with the seas. To determine the degree of navigational error, the search team was required to proceed to a LORAC station, located at a distant oil well. This used up much of that night.

The next morning, the search team recalibrated the navigation equipment at the well and proceeded back to the search area, resetting the reference buoy en route. A second buoy was set adjacent to the first as a precaution, and the search resumed.

Within a half hour a strong contact was recorded by the sonar. Additional passes over the contact revealed a well-defined target with an apparent height of 8 feet. After dropping a buoy to mark the contact and taking a LORAC position reading, the search team headed for Pensacola to pick up a group of Navy divers standing by to conduct wreckage inspections.

The next day, two divers confirmed that the contact was aircraft wreckage. They returned to the surface with a transformer plus a structural piece, and reported that the wreckage was located roughly 80 feet from the buoy. The ship's fathometer then detected the presence of a raised object close by. Divers again investigated, and returned with a piece of wreckage bearing an "A-4" inscription. The divers reported poor visibility and significant tidal currents. Shortly after noon, the OCEAN SURVEYOR returned to Pensacola to disembark the search team and divers, and offload the sonar equipment.

Several days later, on 1 August, the SUPSALV and contractor representatives returned to the crash site aboard the OCEAN SURVEYOR to rendezvous with the U.S. Navy salvage ship USS ESCAPE (ARS-6), which was dispatched to the scene to undertake recovery of the aircraft wreckage. After placing a larger marker buoy at the crash site and transferring the SUPSALV and contractor representatives to the ESCAPE, the OCEAN SURVEYOR returned to her home port.

Conduct of Recovery Operations

The USS ESCAPE had received orders on 27 July to proceed to the crash site, upon completion of duties associated with the Skylab launching. The ESCAPE arrived on-station, with the NAS Meridian Senior Investigator aboard, on 2 August. When the transfer of the SUPSALV and contractor representatives to the ship from the OCEAN SURVEYOR was complete, a salvage conference was held and plans were made to have the ESCAPE divers survey the wreckage area at first light the following day.

On 3 August, the ESCAPE divers found the aircraft fully intact, with only some nose and wing damage. Aided by the technical advice of the Senior Investigator, plus knowledge gained earlier by the SUPSALV and contractor representatives during inspection of a similar aircraft, the divers rigged the sunken aircraft to a TA-4J lift sling acquired from NAS Pensacola. Once raised to the surface, the aircraft was successfully hoisted on deck by the ESCAPE's boom.

The aircraft was examined and given a fresh water wash-down as the ESCAPE proceeded to Pensacola. The ESCAPE arrived at NAS Pensacola in early afternoon, and offloaded the aircraft, completing the rapid and successful recovery operation.

Conclusions

Although the recovery of the aircraft was rapid, search operations were considerably slower due to the frequent need to recalibrate the LORAC navigation system. While the system is accurate to within 25 feet over 100 to 150 mile ranges, it needed to be recalibrated at the start of each search attempt to insure against search lane underlap or overlap.

At one point during the search, the reference buoy broke adrift. This necessitated a 60-mile excursion by the search team to a fixed structure calibration point. The use of double-buoy referencing when using LORAC seems well advised.

As soon as navigation was precisely established, detection of the wreckage by the side-scan sonar was rapid. The sonar recorder range was set for a search path of 500 feet either side of the towed sonar "fish" track. For refining the sonar picture of suspected wreckage, this range was halved to 250 feet for effective resolution.

SEARCH AND RECOVERY OF U.S. NAVY A-7E AIRCRAFT OFF VIRGINIA BEACH, VIRGINIA

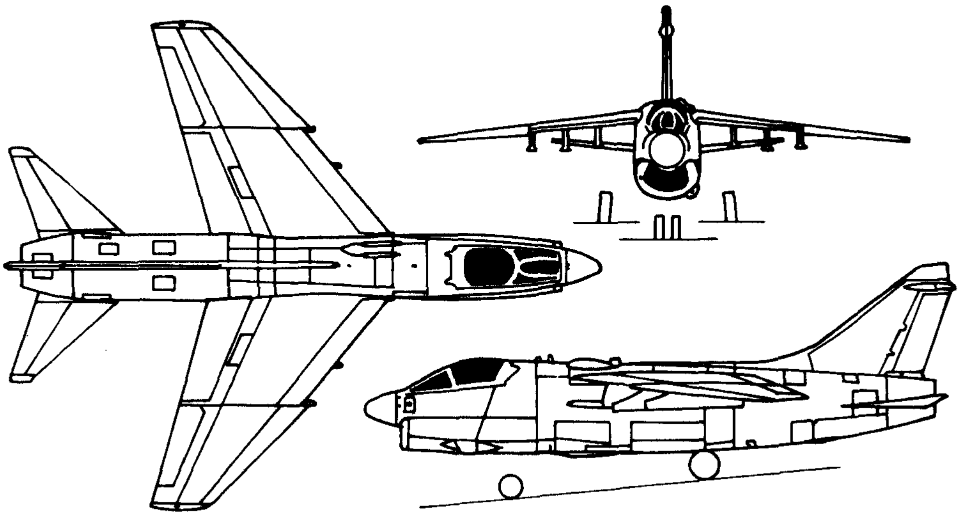
Date:	14 December 1973
Location:	15 miles east of Cape Henry, Virginia, near Chesapeake Bay Light
Condition:	Wreckage in 60 feet of water
Task:	Search and Recovery

Background

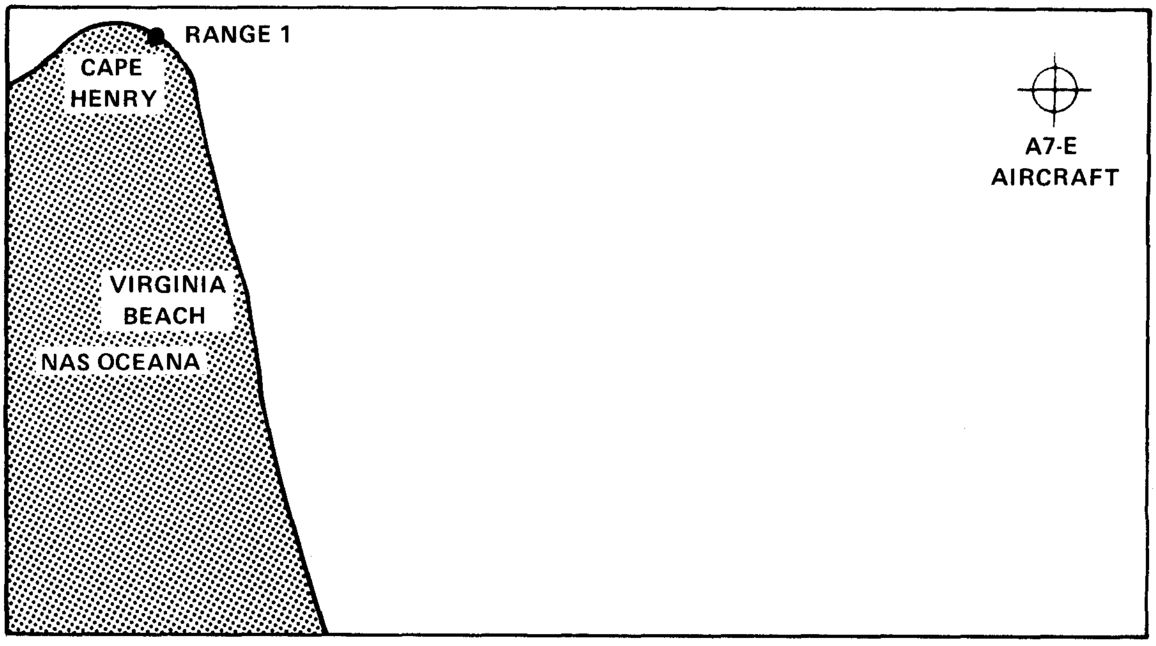
A U.S. Navy A-7E aircraft from the carrier USS FORRESTAL (CVA-59) experienced an engine failure during routine flight operations, on 14 December 1973, and crashed into the Atlantic Ocean approximately 1 1/2 miles east of the Chesapeake Bay Light at the mouth of Chesapeake Bay. The pilot ejected safety at an altitude of 9,000 feet, was picked up and returned to the FORRESTAL. The carrier then steamed to the oil slick left by the aircraft, marked the slick's position, and recorded the wind speed and direction (340° T at 20 knots).

The same day, the U.S. Navy Office of the Supervisor of Salvage (SUPSALV) was notified of the crash, and alerted to the possibility of providing search and recovery assistance. On the morning of 17 December it was decided to attempt to locate and recover the turbofan engine to determine the cause of its malfunction. SUPSALV tasked its prime contractor in search matters, Seaward, Inc., later that morning. By midnight all search equipment and personnel had been mobilized at Little Creek, Virginia.

The EG&G dual side-scan sonar system was selected as the primary search tool for the operation. Positioning of the search vessel was to be accomplished using a Cubic Autotape precision navigation system, which required the establishment of two shore stations to provide the search ship with a digital range readout. The shore stations were established atop the Cape• Henry Lighthouse and on an electronics calibration tower, each approximately



A-7E CORSAIR ATTACK AIRCRAFT



LOCATION OF NAVY A-7E CRASH
OFF VIRGINIA BEACH, VIRGINIA

15 1/2 miles from the crash site. The high precision and repeatability of this system would allow the sonar search to be conducted along parallel, overlapping search tracks. The USS SHAKORI (ATF-162), a 205-foot-long fleet ocean tug, was selected as the search recovery vessel.

As the SHAKORI was being outfitted with the sonar and navigation equipment on 18 December, a SUPSALV representative arrived in Norfolk. With the contractor representative, he obtained details about the crash, reviewed crash site data, and met with a Naval Air Safety Center representative to discuss salvage objectives and physical characteristics of the aircraft.

Conduct of Search Operations

The SHAKORI got under way for the search area at 1745, 18 December. The sonar was streamed out immediately on arrival at 2030. By 0200, 19 December, however, scanning operations were secured due to a problem with the sonar's port transducer. The search team requested a replacement for the faulty sonar at 0700. While awaiting arrival of the sonar, the search team scanned for 8 hours with the sonar's starboard transducer only. Several promising contacts were recorded but proved negative under closer examination.

The SHAKORI headed for port to pick up the replacement sonar at 1700, and was back on the scene to resume operations at 2000. Shortly after midnight, 20 December, a strong contact was recorded approximately 250 yards from the reported crash site. The ship set a buoy over the target, anchored, and at daybreak sent divers down to investigate. The divers confirmed the contact as the aircraft wreckage. Later, a small boat brought additional divers to the SHAKORI for the recovery operations and then returned to shore with the search team and equipment.

The SHAKORI spent the next three days contending with rough seas and bad weather. On 21 December, rain and fog rendered the navigation system inoperable for a short period. During the remainder of the day, the SHAKORI was limited to placing a second marker buoy over the center with the wreckage, and was forced to return to port as weather deteriorated and winds gusted to 50 knots. Although the SHAKORI got under way each day, rough seas prevented the divers from accomplishing more than the setting of marker buoys on scattered pieces of wreckage.

On 24 December the weather subsided. Divers were able to locate and tie a line to a small piece of engine piping and a section of the engine oil cooler. These were recovered, but the engine itself, the primary component required by the Naval Air Safety Center, remained undetected. By late morning, a deteriorating weather situation again halted the diver search, and the SHAKORI returned to port. At a meeting with Commander, Service Squadron Eight, it was decided to secure operations for the Christmas holiday, and to resume the search for the engine on 26 December, when improved weather was expected.

When the diver search for the engine was renewed on 26 December it continued to be unsuccessful. The search team and sonar were therefore called back to the ship. The shore navigation stations, which had been disestablished earlier, were set up again at the lighthouse and tower. However, as the search team was being lifted out to the SHAKORI by helicopter on 27 December, divers located the missing engine in the center of the debris. The sonar was put to use later to search for a bower anchor which the SHAKORI lost in the rough seas earlier in the operation.

Conduct of Recovery Operations

The divers found the engine intact at 1000 on 28 December. The SHAKORI was then repositioned over the engine for a boom lift, and divers began rigging a wire strap around the engine's exhaust end. At 1430, rigging complete, the engine was successfully raised to the surface. It was then washed down with fresh water and secured for sea on the SHAKORI's fantail. The SHAKORI docked at Little Creek at 2100. Offloading of the engine and demobilization of search equipment and personnel were completed the following day.

Conclusions

Although search efforts were plagued by minor equipment difficulties and severe weather conditions, the location and recovery of the aircraft's wreckage on the bottom proceeded relatively rapidly once the side-scan sonar was fully operational.

During the eight-hour period when operations were attempted with only one transducer, search was unsuccessful and effort was expended on a number of false contacts. This suggests that it is probably wise not to expend search effort when side-scan sonar is not fully operational unless some urgent operational factor obtains, such as the engine recovery.

The diver's difficulty in locating the engine in the wreckage area is understandable in view of the extremely poor underwater visibility. As might be expected, once adequate resources were focused on the task, persistence paid off.

INDEX ALPHA

SALVAGE OPERATIONS CUMULATIVE INDEX

1. PURPOSE

This is a consolidated index of salvage operations reviewed in the published series of annual SALVOPS reports:

SALVOPS 69 – NAVSHIPS 0994-012-6010
SALVOPS 70 – NAVSHIPS 0994-012-6020
SALVOPS 71 – NAVSEA 0994-012-6030
SALVOPS 72 – NAVSEA 0994-LP-012-6040
SALVOPS 73 – NAVSEA 0994-LP-012-6050

2. INDEX CATEGORIES

Index listings are presented in the following major categories:

I – Ships/Vessels Requiring Assistance
II – Aircraft Search/Recoveries
III – Miscellaneous Assistance Tasks
IV – Salvage Vessels/Craft/Units
V – Specialized Equipment
VI – Type of Task

3. REPORT/PAGE REFERENCES

Index entries are keyed to the individual SALVOPS report and page number within the report. For example: SALVOPS 72, page 69 is listed as 72-69.

4. RELATED INDEX

See also Index BRAVO for a companion listing and precis of each article contained in the published SALVOPS reports.

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IV. SALVAGE VESSELS, CRAFT, UNITS (cont'd.)

V. SPECIALIZED EQUIPMENT

INDEX BRAVO

ARTICLES IN THE SALVOPS REPORT SERIES

1. PURPOSE

This index lists the articles contained in the published series of annual SALVOPS reports and provides an abstract of each article. Articles are presented in the following sequence:

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SALVOPS 70	–	NAVSHIPS 0994-012-6020
SALVOPS 71	–	NAVSEA 0994-012-6030
SALVOPS 72	–	NAVSEA 0994-LP-012-6040
SALVOPS 73	–	NAVSEA 0994-LP-012-6050

2. RELATED INDEX

See also Index ALPHA for a detailed page index of the types of salvage operations covered thus far in the SALVOPS report series.

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- Search and Recovery of U.S. Air Force B-57 Aircraft in Great Salt Lake, Utah
- Salvage Operations of Harbor Clearance Unit One in Vietnam
- Summary of Downed Aircraft Search and Recovery Operations in 1971

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- Debunkering and Salvage of Dredge ATLANTIC at Elizabeth River, Norfolk, Virginia
- Search and Recovery of USS GEORGE BANCROFT (SSBN-643) Anchor and Chain off Portsmouth, N.H.
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- Summary of Downed Aircraft Search and Recovery Operations in 1972

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ABSTRACTS OF SALVOPS 1969 ARTICLES

Recovery of Deep Research Vehicle ALVIN

ALVIN, a manned submersible, was lost in 5,050 feet of water in October 1968 off Cape Cod, Massachusetts. Initial efforts to recover the submersible in the fall of 1968 were unsuccessful. ALVIN was located again the following year, and salvage efforts were conducted in August. ALUMINAUT, another manned submersible, dived to the bottom, homed in on the wreck with sonar and attached lift lines with its manipulators. ALVIN was then raised, towed to shallow water and recovered.

Recovery of Implanted Acoustical Beacon SNAP-7E

SNAP-7E, an experimental beacon moored in 16,000 feet of water off Bermuda, mysteriously ceased operation in October 1968. The recovery plan called for snagging one of the mooring legs using grapnels. Recovery operations began on 23 November 1969, and after 4 days and several unsuccessful passes, the elusive mooring leg was hooked, and the buoy recovered.

Recovery of ex-USS HAKE in SUBSALVEX-69

In May 1969 the ex-USS HAKE, a submarine hulk, was sunk in Chesapeake Bay at a depth of over 100 feet. This action was taken to provide a practical training exercise and a re-evaluation of the concept of raising submarines with large, rigid pontoons. Preparations continued throughout May, culminating in a final lift on May 22. All deadlines were met, much salvage expertise developed, and the validity of the pontoon concept again established.

Salvage of the Nuclear Submarine USS GUITARRO (SSN-665)

The USS GUITARRO, in final stages of construction at the San Francisco Naval Shipyard, sank alongside the pier in 30 feet of water on 15 May 1969. The salvage plan included the use of cofferdams fitted over the sub's hatches to make the hull watertight, the blowing of strategic tanks for buoyancy, and a floating crane to provide lift. All preparations were completed, and the submarine successfully refloated on 18 May.

Efforts to Recover the Dredge SANDPUMPER

On 22 September 1969, while operating in the My Tho River near Dong Tam, South Vietnam, the dredge SANDPUMPER suffered an explosion in her suction pump and sank in 35 feet of water. Two heavy lift craft partially raised the dredge and moved it to shallow water for dewatering. However, widespread mudding and flooding prevented final recovery and operations were terminated in mid-December.

Recovery of the Dredge NEW JERSEY

On 22 November 1969 the dredge NEW JERSEY, while conducting operations in the My Tho River near Dong Tam, South Vietnam, struck a mine and sank in 20 feet of water. Harbor Clearance Unit One was tasked with the salvage effort. Using standard patching and pumping techniques, the damaged areas were made watertight and the dredge refloated.

Efforts to Raise Motor Vessel POWIS off Coast of Guyana

The M/V POWIS, on 22 February 1969, struck a submerged barge, flooded and settled atop the barge. After difficulty was experienced by local salvage forces, the assistance of the Supervisor of Salvage was requested. The SUPSALV Representative developed a salvage plan, supervised the preliminary stages, and set the groundwork for the successful completion of the task.

Salvage of Grounded Vessel SS ALAMO VICTORY

ALAMO VICTORY, an MSTS cargo ship, was driven hard aground at Gulfport, Mississippi during Hurricane Camille in August 1969. A SUPSALV contractor was tasked with the retraction. Six sets of beach gear were used to refloat the vessel by pivoting into an 18-foot channel dredged from the grounding site into deep water. Retraction was completed on 18 September.

Salvage and Towing of USS FRANK E. EVANS (DD-754)

On 2 June 1969, while maneuvering in the South China Sea, the destroyer EVANS was rammed and cut in half by the Australian Aircraft Carrier HMAS MELBOURNE. The bow section sank immediately; however the stern remained afloat. Quick, effective damage control efforts by LARSON (DD-830) and TAWASA (ATF-92) brought flooding under control and prevented the stern from sinking. The stern was then towed 825 miles to Subic Bay, Philippines.

Salvage of Grounded Vessel SS NORWICH VICTORY

The SS NORWICH VICTORY, en route to Vietnam with a cargo of ammunitions and fuel oil, ran hard aground on 25 September 1969 off Triton Island. CONSERVER (ARS-39), GRAPPLE (ARS-7), GRASP (ARS-24) and CHOWANOC (ATF-100) participated in the ensuing retraction. Seven legs of beach gear were layed and 1,875 tons of cargo offloaded. After several unsuccessful attempts, the NORWICH VICTORY was pulled free on 8 October, and proceeded to Danang, South Vietnam.

Aircraft Search and Recovery Activities

This article summarizes operations undertaken to locate and recover five downed aircraft in 1969. Portions of three aircraft, a USAF T-33 jet trainer, a USAF HH-53C helicopter and a Scandanavian DC-8 airliner, were recovered. Two jet fighters, a USN A4-F and a USAF F-106 could not be recovered.

ABSTRACTS OF SALVOPS 1970 ARTICLES

Recovery of Bunker "C" Fuel Oil from the Sunken Tanker SS ARROW

In February 1970 the tanker SS ARROW ran aground, broke in two and sank in 90 feet of water, resulting in a major oil spill in Chedabucto Bay, Nova Scotia. To prevent further spillage, the oil remaining in the sunken tanker was removed using a steam supported pumping system and the hot tap method of hull penetration. Despite near freezing temperatures, over 37,000 barrels of oil were recovered from the wreck by the time operations were secured on 11 April.

Blowout of Chevron Oil Well Platform Along the Gulf Coast

A Chevron multi-well oil platform exploded and burned in the Gulf of Mexico off the Louisiana coast on 10 February 1970. During the period between extinguishing the fire and capping the wells, a significant oil spill was expected. To contain this spill and prevent damage to the nearby oyster and shrimp industries, an oil boom and skimmer were employed. Damage to the local beaches and industry was avoided despite occasional breaks in the boom.

Salvage of the ex-USS REUBEN JAMES (DE-153) at Dahlgren, Virginia

The hulk of the destroyer escort ex-REUBEN JAMES, rolled onto her starboard side and sank in 10 feet of water off Dahlgren, Virginia on 14 March 1970. Harbor Clearance Unit Two, tasked with righting and refloating the ship, devised a 6-phase salvage plan. By 9 April, using beach gear and dewatering, the original 87 degree list had been reduced to 7 degrees. The hull was then made watertight and stability tests run in preparation for refloating, which was accomplished on 16 April.

Salvage of the Sunken Harbor Tug YTM-538 at Mayport, Florida

YTM-538 was struck below the waterline by a propeller of the USS PAWCATUK (AO-108) while assisting the oiler into Mayport, Florida on 17 July 1970. The tug sank on an even keel in 41 feet of water on the south side of the channel to the Naval Station basin. Using floating cranes and beach gear, Harbor Clearance Unit Two lifted the tug from the channel in just over one month. The YTM was refloated and moved onto a marine railway on 1 August.

Search and Recovery of Solar Eclipse Instrumentation Package off Virginia Capes

A rocket pod carrying vital photographic coverage of a solar eclipse sank in 5,850 feet of water, 75 miles east of Norfolk, Virginia on 7 March 1970. Operating from the USS OPPORTUNE (ARS-41) the unmanned submersible CURV III was used for search and recovery. On 22 March, eight hours into the second dive, the missing package was located and the submersible's claw attached to it for lifting. CURV then brought the package to the surface where it was hoisted aboard the OPPORTUNE, undamaged.

SQUAW – Submerged Mooring of a Model Submarine Hull

SQUAW, a sonar training target moored at a depth of 300 feet off San Diego, California, unexpectedly broke its moor and surfaced in early 1970. The Supervisor of Salvage was tasked to undertake the re-mooring operations. Three ships, the USS CHAWANOC (ATF-100), the USS MOLALA (ATF-106) and the USS KALMIA (ATA-187) completed the task within seven days, using a drop system for implanting the moor. The moor, consisting of four legs, was designed to hold the SQUAW in position 300 feet below the surface, in 3,492 feet of water for 5-10 years.

Implantment of Hydrophone Array Tower off Block Island, Rhode Island

The barge YC-1429, with a 100-foot hydrophone array tower installed, was intentionally sunk in 104 feet of water in November 1970 for experimental use. Careful preparations and planning led to a successful controlled flooding, sinking and positioning of the tower and barge. Once bottomed, the barge was rotated to the position where the hydrophone array would be most effective.

Salvage Operations of Harbor Clearance Unit One in Vietnam

Using highly mobile salvage craft and teams, Harbor Clearance Unit One conducted a variety of salvage operations in South Vietnam in 1970, frequently under hostile fire. These operations included groundings, collisions, breakdown and enemy action. By the end of 1970, the U.S. reduction in force had begun, HCU-1's in-country manning level reduced, and a number of her salvage craft turned over to the South Vietnamese Navy.

Underwater Search and Recovery of Aircraft in Lake Mead, Nevada

On 25 November 1970 a Cessna U-206 aircraft crashed into Lake Mead, Nevada, sinking in 400 feet of water. Because of the great depth, the ADS-IV deep diving system was used for search and diving operations. Despite the onset of winter, near zero bottom visibility and a heavy layer of silt, the aircraft was quickly located. Divers then attached a specially constructed sling to the aircraft, and it was recovered on 7 December.

Summary of Downed Aircraft Search and Recovery Operations in 1970

Of the aircraft search and recovery operations conducted in 1970, six were considered significant and were included in this article. Search and salvage operations were conducted on two Navy F-4J Phantoms, two Navy A6A Intruders, as well as one Air Force F-4D Phantom. An intensive search was also conducted for an F-102 Interceptor in the Gulf of Mexico, with negative results.

ABSTRACTS OF SALVOPS 1971 ARTICLES

Salvage Efforts and Disposal of USS REGULUS (AF-57) off Hong Kong

The USS REGULUS was driven aground by Typhoon Rose on 17 August 1971. Salvage efforts, limited to offloading of stores, oil and other salvageable materials, were conducted by the USS SAFEGUARD (ARS-25), USS GRASP (ARS-24) and the USS ABNAKI (ATF-96). During these operations an extensive survey was performed, and it was decided that the REGULUS was beyond economical repair and should be stricken and sold, with the stipulation that the hulk be quickly removed. Topside weight was removed, the hull cut into two sections, and each section removed.

Participation of U.S. Forces in Azores Fixed Acoustical Range (AFAR) 1971 Operations

The installation of AFAR in 1970 had not resulted in a useable facility. Repairs were required to the transmitting tower, two receiving stations and an oceanographic buoy. The USS KIOWA (ATF-72) and the USS NAUBUC (YRST-4) worked together to implant the buoy. CURV III, an unmanned submersible operating from the NAUBUC, attached special fittings to the transmitting tower and connected them to a recovery vessel. CURV also located the cables to the receiving stations and prepared them for retrieval.

Recovery of the Ketch ATOM from Assateague Island, Virginia

On 25 October 1971, the ketch ATOM went aground on Assateague Island. Civilian volunteers immediately went to the assistance of the 69 year old French owner, but were unable to refloat the stranded craft. The U.S. Navy provided a team of salvage experts which succeeded in refloating the ATOM on 6 November.

Recovery of ex-USS HAKE in SUBSALVEX-71

The ex-USS HAKE, a submarine hulk, was intentionally sunk in Chesapeake Bay on 9 August in 100 feet of water for use in SUBSALVEX-71. The exercise had three purposes: to provide experience and training for personnel; to evaluate the effectiveness of submarine salvage techniques; and to test actual submarine salvage equipment. USS OPPORTUNE (ARS-41) and USS PRESERVER (ARS-8), supported by Harbor Clearance Unit Two, rigged all pontoons and prepared the submarine for the lift. The ex-HAKE was surfaced and towed back to port on 13 September.

Search and Recovery of U.S. Air Force B-52 Aircraft in Lake Michigan

On 7 January 1971 a B-52 aircraft crashed into Lake Michigan in 240 feet of water. A detailed search, using side-scan sonar, located the wreckage. Recovery efforts were postponed until spring. The salvage forces assembled again in May, this time with the ADS-IV deep diving system. Despite the depth, cold water and near zero visibility, the required pieces of wreckage were recovered. SALVOPS were terminated on 13 June.

Use of Pressurized Sphere Injector (PSI) in Lifting the Barge BOOTH from the Gulf of Mexico

The pipelaying barge BOOTH was sunk in 50 feet of water by a storm in 1969. To raise the barge, a unique method of overcoming negative buoyancy was utilized. Using Pressurized Sphere Injector (PSI) machinery, thousands of 11-inch plastic spheres were injected into the barge, displacing the water. This method successfully raised the 2400-ton barge on 23 August.

Search and Recovery of U.S. Air Force B-57 Aircraft in Great Salt Lake, Utah

An Air Force B-57 aircraft crashed into 22 feet of water in the Great Salt Lake on 13 April 1971. Utilizing a precision navigation system and side-scan sonar, the wreckage was quickly located. Divers from HCU-2 and other facilities assisted in recovering the wreckage. By 9 June, all required wreckage had been recovered, and operations were terminated.

Salvage Operations of Harbor Clearance Unit One in Vietnam

HCU-1 performed river clearance tasks in the Mekong Delta in early 1971, using LCM-8s rigged with A-frames as salvage lift craft. The unit also patched the mine-damaged SS ROBIN HOOD. The unit's work in training and equipping Vietnamese salvage forces is highlighted. HCU-1's active salvage role in Vietnam ended in June 1971.

Summary of Downed Aircraft Search and Recovery Operations in 1971

During the year 1971 the Supervisor of Salvage provided assistance for the search and recovery of four lost aircraft. Two of the aircraft were Navy F-4J Phantoms, one of which was successfully located and recovered. A Marine Corps helicopter was also successfully recovered from Chesapeake Bay. In addition, ninety percent of an Air Force F-4 Phantom was retrieved from near Tampa, Florida.

ABSTRACTS OF SALVOPS 1972 ARTICLES

Recovery and Disposal of SS SIDNEY E. SMITH JR. from the St. Clair River, Port Huron, Michigan

The sunken coal freighter, SIDNEY SMITH, broken in two sections, partially blocked the shipping channel opposite Port Huron and presented a grave navigational hazard. Each wreck section was first lightened by installing polyurethane foam for buoyancy and then removed from the channel with hydraulic pullers. The recovered sections were then prepared for final disposal. Salvage operations began 22 June and concluded 18 November.

M/V ORIENTAL WARRIOR Oil Pollution Control and Debunkering Operations

Following a fire at sea, the ORIENTAL WARRIOR was towed into Jacksonville, Florida where the vessel sank alongside a pier. Initial efforts managed to contain a 90,000-gallon oil spill. An oil recovery team debunkered the WARRIOR, recovering 290,000 gallons of oil. Recovery methods included vacuum pumping, skimming, blowing and hot tapping. Throughout the operation oil containment measures prevented a major oil spill.

M/V ORIENTAL WARRIOR Salvage and Disposal Operations

Debunkering completed, the salvors undertook the task of refloating the flooded and fire-damaged WARRIOR. Although essentially a patch and pump operation, the task was far from routine as the hull was severely weakened amidships. A controlled combination of dewatering, ballasting and parbuckling was required to refloat it without breaking the hull. The task was accomplished on schedule and the hull disposed of at sea by sinking it with explosives on 1 October 1972.

Recovery of Oil from M/V SOLAR TRADER at West Fayu Island, Pacific Island Trust Territory

The M/V SOLAR TRADER ran aground in late December 1971. It had been slowly leaking oil for six months when SUPSALV received a request for oil pollution abatement assistance. An oil pollution specialist was dispatched to the scene and arrangements made to debunker the vessel. In a nine-day effort ending 23 July, 45,000 gallons of oil were removed from the wreck. Minor oil spills were contained and removed with booms and a skimmer.

Search and Recovery of U.S. Coast Guard Air Cushion Vehicle from the Straits of Mackinac, Lake Huron

The air cushion vehicle, ACV-3, sank in 110 feet of water on 23 November 1971. It was left in place over the winter when initial recovery attempts failed. Operations resumed in June 1972 with the USCG SUNDEW as the lift platform. The vehicle was first lifted to a depth of 40 feet where divers attached a specially designed sling for hoisting it aboard the SUNDEW. Recovery was accomplished on 12 June.

Debunkering and Salvage of Dredge ATLANTIC at Elizabeth River, Norfolk, Virginia

SUPSALV assistance was requested in August 1972 to halt the spread of oil pollution from the sunken dredge ATLANTIC, and to remove the dredge and two smaller craft sunk adjacent to it. Oil containment and removal equipment were immediately employed and the dredge stripped of accessible remaining oil. The two smaller craft were pulled clear and salvage operations begun on the dredge. Salvage operations included the use of beach gear, patching, pumping and a large plastic sheath around the hull.

Search and Recovery of USS GEORGE BANCROFT (SSBN-643) Anchor and Chain off Portsmouth, N.H.

On 5 July 1972, the nuclear submarine GEORGE BANCROFT lost her anchor and 135 fathoms of chain in 400 feet of water. On 11 June, in just seven minutes of active searching with side-scan sonar, the anchor and chain were located. The USS NIPMUC (ATF-157), using an anchor hawk, snagged the chain that evening on the fourth attempt. The anchor and chain were recovered the next day.

Recovery of USS TUCUMCARI (PGH-2) from Caballo Blanco Reef off Puerto Rico

The hydrofoil gunboat TUCUMCARI struck a submerged reef at high speed on 16 November 1972. On impact, the forward strut collapsed, while the two main struts embedded themselves deeply in the coral. Preparations to refloat the craft using beach gear were begun by the M/V RESCUE. Several retraction attempts were made, but the embedded struts held the craft firmly to the reef. On 21 November, with two tugs assisting the RESCUE and a helicopter providing lift to the stern, TUCUMCARI was pulled from the reef.

Search and Recovery of U.S. Air Force F-4E Aircraft off Coast of Turkey

On 8 September 1972 an Air Force F-4E aircraft crashed in 130 feet of water. Using the USS PRESERVER as a surface support platform, an intensive search for the wreckage was conducted with side-scan sonar. After 13 days, the aircraft was finally located well outside the prime search area. During the four days of salvage efforts that followed, the PRESERVER recovered enough of the wreckage so that an accurate determination of the cause of the accident could be made.

Summary of Downed Aircraft Search and Recovery Operations in 1972

This article reviews five aircraft search and recovery operations conducted by the Navy in 1972. Two were for fighter aircraft, a Navy F-14 and an Air Force F-4E; both were successful. A Navy TA-4J was successfully located but recovery efforts were foiled by adverse weather. In addition, a Navy HH-2C helicopter was located and recovered, as well as two Air Force RA-4C aircraft which had been in a mid-air collision.

ABSTRACTS OF SALVOPS 1973 ARTICLES

Rescue of the Deep Submersible PISCES III and Crew from 1,600 Feet

The mini deep submersible PISCES III, was flooded during recovery by its mother ship VICKERS VOYAGER, during transatlantic telephone cable-burying operations off the Irish Coast. It plummeted to the bottom where it was trapped with its 2-man crew. Seventy-two hours later, CURV III, flown in from San Diego, California, succeeded in attaching a line with which PISCES and its crew were hauled to the surface and saved.

Prompt, Economical Underwater Repairs to USS F.D. ROOSEVELT (CVA-42)

Twice in 1973, emergency repairs were provided for the ROOSEVELT by means of rapid, effective, underwater work techniques. A badly damaged port rudder was repaired and the packing of the stern tube gland of #3 propeller shaft was replaced. In both cases, time consuming and expensive diversion to a drydock was avoided.

Salvage Efforts and Stripping of USNS JACK J. PENDLETON (T-AK-276)

The PENDLETON was severely grounded at 17.5 knots at high tide on Triton Island in the South China Sea. A deck load of 100 tons (two generators) over #2 hold – too heavy for the equipment on-scene – precluded unloading a crucial 280 tons in #2 hold, which was located over the point of grounding. In the short time available, retraction proved impossible. Four typhoons then pounded the area, broaching PENDLETON to, 70 yards further onto the reef. It was declared a loss and salvage was limited to stripping cargo, valuables, and fuel.

Foam "Sink-proofing" of LST for Test of Haiphong Minesweeping

Successful completion of Project ENDSWEEP, the minesweeping of Haiphong Channel, had to be demonstrated by means of safe channel transit by a ship. An LST was chosen for the task and had to be made "sink proof" by filling buoyant spaces with polyurethane foam. This was accomplished in record time and the channel transited safely and successfully.

Clearance of Tug Wreck from Coney Island Channel

In 1973 the U.S. Army Corps of Engineers' dredging program for New York Harbor was impeded by a tug hull in the Coney Island Channel. USS OPPORTUNE and her divers succeeded in passing chain-slings under the wreck. The slings were then used to raise the wreck from the channel-bottom, by means of the bow lift system of the OPPORTUNE, which then deposited the wreck in deep water.

Removal of Fouled Ground Tackle From Deepwater Petroleum Offloading System, Estero Bay, California

In attempting to enter a moor to offload jet fuel at Estero Bay, the USNS SUAMICO fouled its anchor in the hose line bottom connection. SUAMICO dropped its anchor, which a salvage team was able to retrieve without damage to the hose. The operation was safeguarded against pollution by first enclosing the site with oil containment booms. Fortunately this necessary precaution was not tested by any spillage of the jet fuel involved.

1973 Operations in Support of the Azores Fixed Acoustical Range (AFAR)

In July 1973, the Director of Ocean Engineering conducted a sequence of operations during the good summer weather, designed to bring AFAR to full operating capability. The tasks included; properly reorienting one of the three 120-foot high acoustic towers mounted on the sea bottom at 1,000 feet; retrieving, refurbishing, and replacing a 5000-pound underwater environmental monitoring buoy moored 200 feet below the surface; adding a NOMAD weather buoy to the system; and calibrating the AFAR system and components.

Support Operations for the Joint Casualty Resolution Center (JCRC) Southeast Asia

During an 82-day period, 77 square miles of coastal ocean bottom were searched for aircraft wreckage with personnel remains, to resolve the status of men listed as missing in action (MIA). Using the highly discriminating side-looking sonar, 36 positive contacts were obtained, 14 of which were aircraft related.

Recovery for Crash Analysis of P-3B Aircraft off Brunswick, Maine

In March 1973, a Navy P-3B crashed in the Atlantic shortly after takeoff on a local test and training flight. Proceeding from fixes hastily determined after the crash, the ALCOA SEAPROBE was used to conduct a successful search for the wreckage, which was deemed critical for accident analysis and prevention. Subsequently, ALCOA SEAPROBE was able to use its unique oil-well drill-pipe mounted system to recover the necessary wreckage. Assisted by the USS EDENTON (ATS-1), the wreckage was delivered to NAS Brunswick, for analysis.

Summary of Downed Aircraft Search and Recovery Operations in 1973

During the year 1973, the Supervisor of Salvage provided assistance for the search and recovery of five aircraft, in addition to the above P-3B. This included the following Navy types: an F-4B fighter, an HH-2D helicopter, an A-7E attack aircraft, and a TA-4J trainer; as well as a USAF RF-4C photo recon type.

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