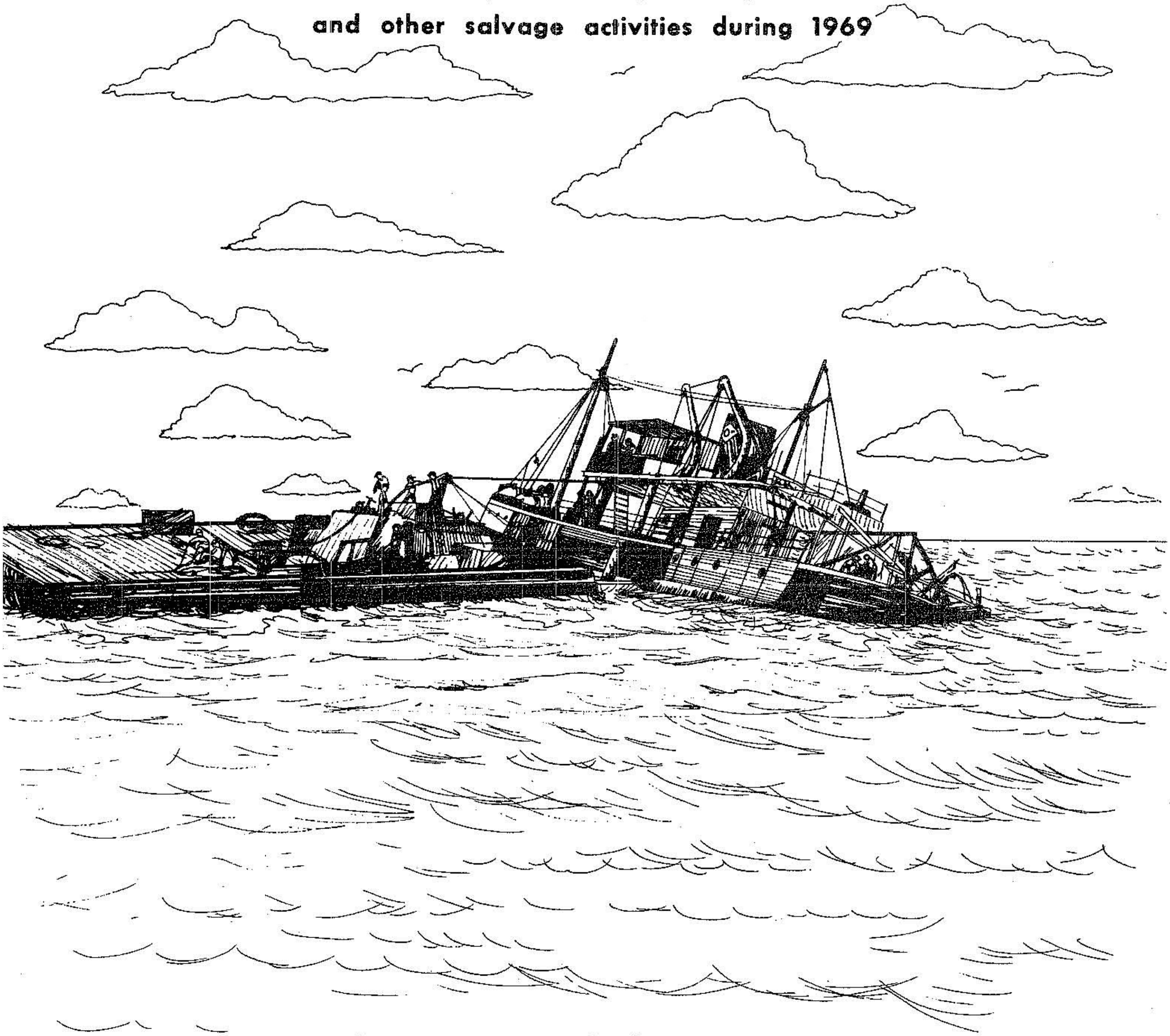
NAVSHIPS 0994-012-6010

SALVOPS 69

A review of significant salvage operations conducted by U.S. Navy salvage forces and other salvage activities during 1969



Department of the Navy
Naval Ship Systems Command
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FOREWORD

It is often said, and truly so, that experience is the best teacher. Few would question the value of learning by doing, of learning from personal experience. But it is also true that personal experience is not the only teacher. It cannot be; there is simply too much to be learned. We must also learn from the experience of others; that is, through study and reading. Professionals recognize this. The need to learn from someone else's experience accounts for their intense, continuing interest in what other professionals in their fields are doing.

This book has been prepared primarily for those who have a professional interest in the complex and difficult business of marine salvage. It is a short review of significant salvage operations during 1969. Most of the operations reviewed were conducted by U.S. Navy salvage forces. All salvors, however, commercial as well as Naval, can gain something by reading about these operations. They can see in them situations, techniques and lessons that are worth pondering. They can, in short, learn from the experience of other salvors faced with problems not unlike their own.

Here, then, is a picture of professional salvage men at work in 1969. Working, as usual, under dangerous conditions. Working against time and its implacable allies, the seas and the weather. Working much as salvage men do today and will do in the future. And, in the process, accumulating a record of their experience for the benefit of other professionals.

E. B. MITCHELL
Captain, USN
Supervisor of Salvage, U.S. Navy

ABSTRACT

This is an annual operations report of the Supervisor of Salvage, U.S. Navy, summarizing 15 cases of significant salvage operations conducted during 1969 and reviewing the principal lessons learned in each case. The report is intended for general reading by all interested members of the salvage community; it covers the operations of contractor salvors as well as those of U.S. Navy salvage forces. Operations to recover sunken vessels are highlighted. These include the recovery of the deep research vessel, ALVIN, from a depth of 5051 feet off Cape Cod, Massachusetts; the raising of the dredges SAND PUMPER and NEW JERSEY in the My Tho River, Vietnam; and the refloating of the nuclear attack submarine, USS GUITARRO in San Francisco Bay. The exercise, SUB SALVEX-69, in which a submarine hull was raised with salvage pontoons, is given detailed treatment. The report further describes operations to recover grounded vessels such as SS ALAMO VICTORY and SS NORWICH VICTORY; operations to locate and recover downed aircraft; and the successful effort to retrieve SNAP-7E, an acoustical beacon, from a depth of 16,000 feet off Bermuda.

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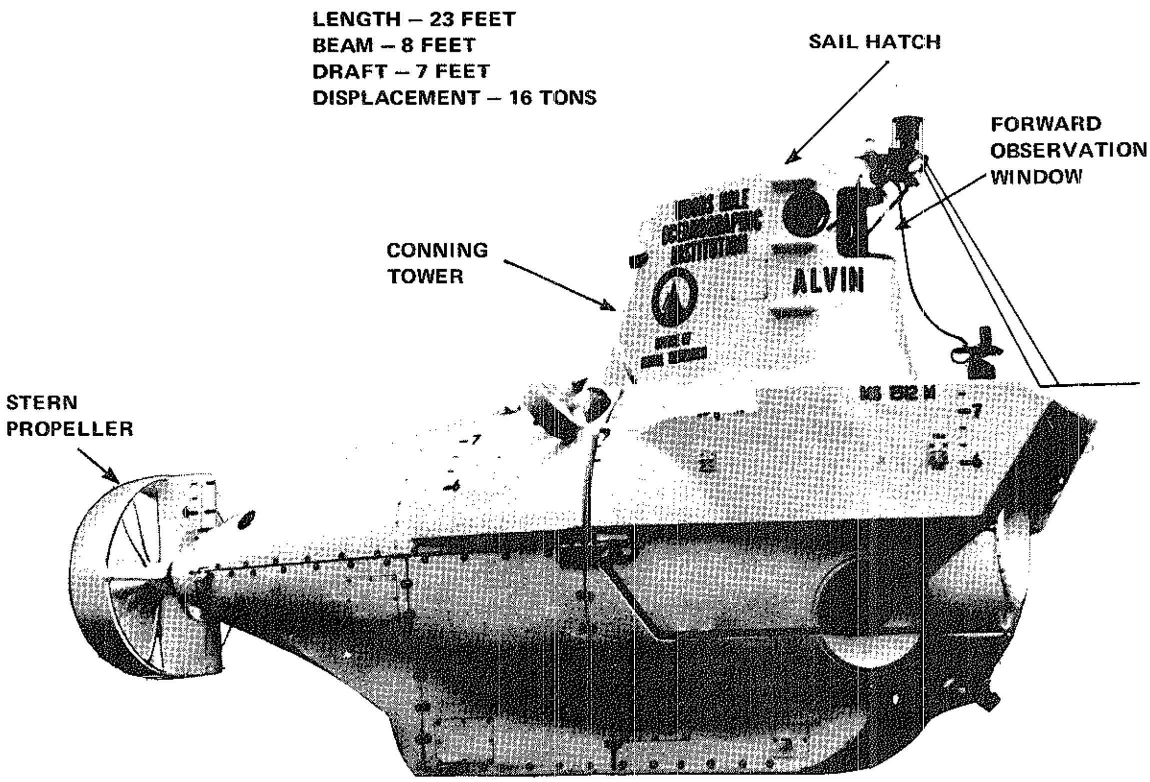
RECOVERY

OF

DEEP RESEARCH VEHICLE ALVIN

7-FOOT PRESSURE SPHERE INSIDE HULL UNDER CONNING TOWER IS MADE OF HIGH STRENGTH STEEL, 1:33 INCHES THICK. PRESSURE SPHERE HAS ROOM FOR ONE PILOT AND TWO OBSERVERS TOGETHER WITH INSTRUMENTATION AND LIFE SUPPORT EQUIPMENT. FOUR VIEWING PORTS PERMIT PILOT AND OBSERVERS TO SEE AHEAD OF AND BENEATH THE VEHICLE.



CAPABILITIES:

POWER – FROM THREE BANKS OF LEAD-ACID BATTERIES WHICH MAY BE DROPPED IN AN EMERGENCY
TOP SPEED – 3 KNOTS
CRUISING SPEED – 1.5 KNOTS
SUBMERGED RANGE – 10 TO 15 MILES
ENDURANCE – >24 HOURS
OPERATING DEPTHS – TO 6000 FEET WITH >2.6 SAFETY FACTOR

NORMAL EQUIPMENT INCLUDES:

CLOSED CIRCUIT TV
TWO 35MM OUTSIDE CAMERAS WITH STROBE
SCANNING SONAR
FATHOMETER
DEPTH AND TEMP. INSTRUMENTATION
GYROSCOPE AND MAGNETIC COMPASS
UNDERWATER TELEPHONE
MARINE BAND RADIO

CHARACTERISTICS AND CAPABILITIES OF
DEEP RESEARCH VEHICLE ALVIN

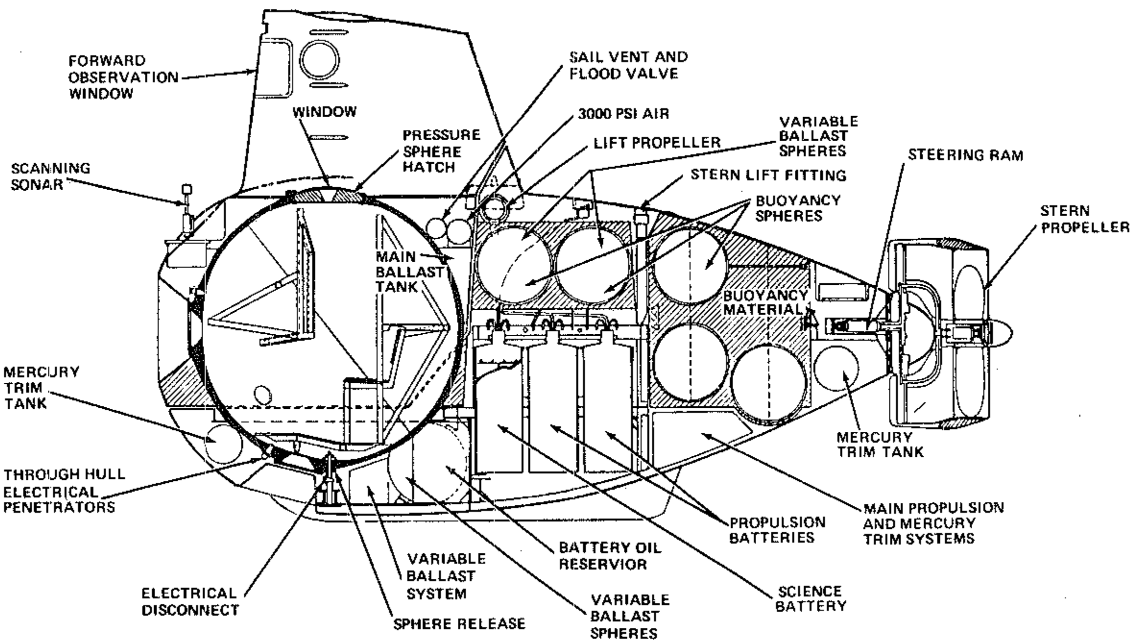
RECOVERY OF
DEEP RESEARCH VEHICLE ALVIN

INTRODUCTION

The Deep Research Vehicle (DRV) ALVIN was lost in October 1968 off Cape Cod, Massachusetts. The 15-ton, 23-foot manned submersible sank in 5051 feet of water when steel cables and nylon retaining lines snapped while she was being launched from her mother ship. Initial efforts to recover her in the fall of 1968 were unsuccessful.

Designed primarily for deep-diving oceanographic research, ALVIN had successfully completed 307 dives at the time of her loss. Owned by the U.S. Navy and operated by the Woods Hole Oceanographic Institution, she represented a 1.5 million dollar investment and was one of the few deep research vehicles capable of 6000-foot diving depths. She had gained international fame in 1966 when she helped locate and retrieve a hydrogen weapon off the coast of Spain.

ALVIN was successfully raised on 1 September 1969 in a unique salvage operation which constituted a major step forward in the Navy's capability to conduct deep ocean engineering operations. The operation involved relocating the vessel, marking it with transponders, using the DRV ALUMINAUT to attach lift lines, lifting it to the surface and towing it to shallow water for final recovery. This was the first time that an object of ALVIN's size and weight had ever been recovered from such great depths.



Salvors were particularly interested in ALVIN's sail hatch and pressure sphere hatch as openings for insertion of lifting devices.

ALVIN IN CROSS SECTION

For the complete report, see ALVIN, NAVSHIPS 0994-004-5010.

CIRCUMSTANCES OF ALVIN'S LOSS

Sinking of ALVIN During Launching Operations

The Research Vessel (R/V) LULU, with ALVIN aboard, departed Woods Hole, Massachusetts, accompanied by R/V GOSNOLD during October 1968. The two research vessels were to conduct operations at sea, employing ALVIN at depths in excess of 5000 feet. Operations were terminated abruptly on 16 October when ALVIN broke loose from LULU as she was being lowered over the side of the mother ship. Two steel cables on LULU's launch cradle snapped, causing the submersible and her three-man crew to plunge into the water.

ALVIN sank below the surface and then popped up quickly. Immediate and effective action by LULU's captain and crew enabled ALVIN's crew to scramble from the inside of the submersible to safety aboard LULU. The research vessel's crew members held fast to the heavy nylon retaining lines which had been attached to ALVIN for the launching. Concurrently, LULU's captain moved the catamaran forward, thus providing clearance for ALVIN's crew to escape from the floundering vehicle.

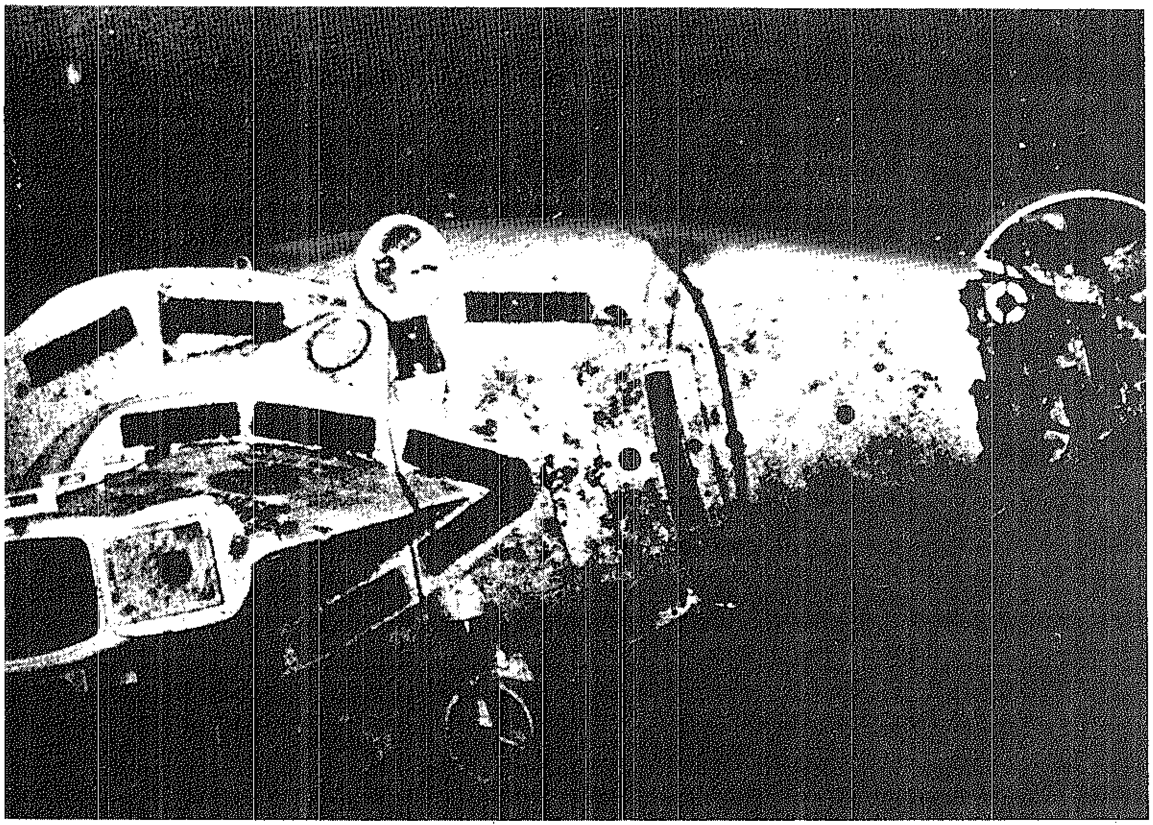
Although the danger to personnel had been averted, it was not possible to prevent the 15-ton submersible from sinking. ALVIN was soon down by the bow. She was flooding rapidly through an open hatch on the pressure sphere and a broken forward observation window in her conning tower. The retaining lines then snapped before further preventive action could be taken and ALVIN plunged to the ocean floor, over 5000 feet below the surface.

Estimates of Location and Damage

GOSNOLD and LULU remained at the scene for two days following the ALVIN's loss. The two research vessels surveyed the area carefully, narrowing the projected search site to an area of one square mile. They estimated the submersible's position to be at latitude 39°53.5′ N and longitude 69°15.5′ W, about 88 miles south of Nantucket Island.

It was not possible to make a detailed estimate of possible damage to ALVIN at this time. LULU's crew members had observed, however, that the initial impact of plunging into the water had knocked off ALVIN's stern propeller. It was also surmised that she sustained other damage in the stern area, possibly to facilities such as the trim tanks, the buoyancy control mechanism and the steering propulsion mechanism. Salt water damage to instrumentation in the pressure sphere was expected to be extensive. Damage from impact on the bottom was also a possibility. The consensus was that she had dropped at a speed of approximately 10 knots, at a 45° to 60° nose-down angle, and with hatch open. The bottom was thought to be firm clay covered by silt.

An effort to recover ALVIN was undertaken in the late fall of 1968. The North Atlantic winter soon intervened, with severe weather and adverse sea conditions preventing further operations. However, ALVIN was located and photographed during June 1969 by a towed sled of USNS MIZAR, a research vessel operated by the Military Sealift Command for the Naval Research Laboratory. ALVIN was found to be in an upright position, resting in 2–3 feet of silty mud, with her bow down 10–15 degrees. The photographs showed that her sail hatch was open. ALVIN appeared intact except for her stern propeller and shroud which had torn loose. It could not be determined if her pressure hatch was open.



This photograph revealed that ALVIN was readily accessible to salvage attempts, being basically in an upright position. Confirmation that her sail hatch was still open was also important in salvage planning. Status of the pressure sphere hatch remained unknown, however.

ALVIN ON OCEAN FLOOR AS PHOTOGRAPHED BY USNS MIZAR IN JUNE 1969

FACTORS JUSTIFYING A SALVAGE ATTEMPT

Salvage Value

ALVIN was an extremely valuable research vehicle. Her worth was judged not merely by the 1.5 million investment that she represented but also by her potential for future deep oceanographic operations. Her salvage value clearly exceeded the estimated costs of any recovery operations.

Technical Considerations

Recovery was deemed to be within the state of the art. More importantly, however, no recovery had ever been achieved of an object of comparable size at depths in excess of 5000 feet. Recovery operations at such depths could serve to verify the technologies and techniques involved and to reveal unsuspected deficiencies.

Behavior of Materiels in Deep Ocean Environment

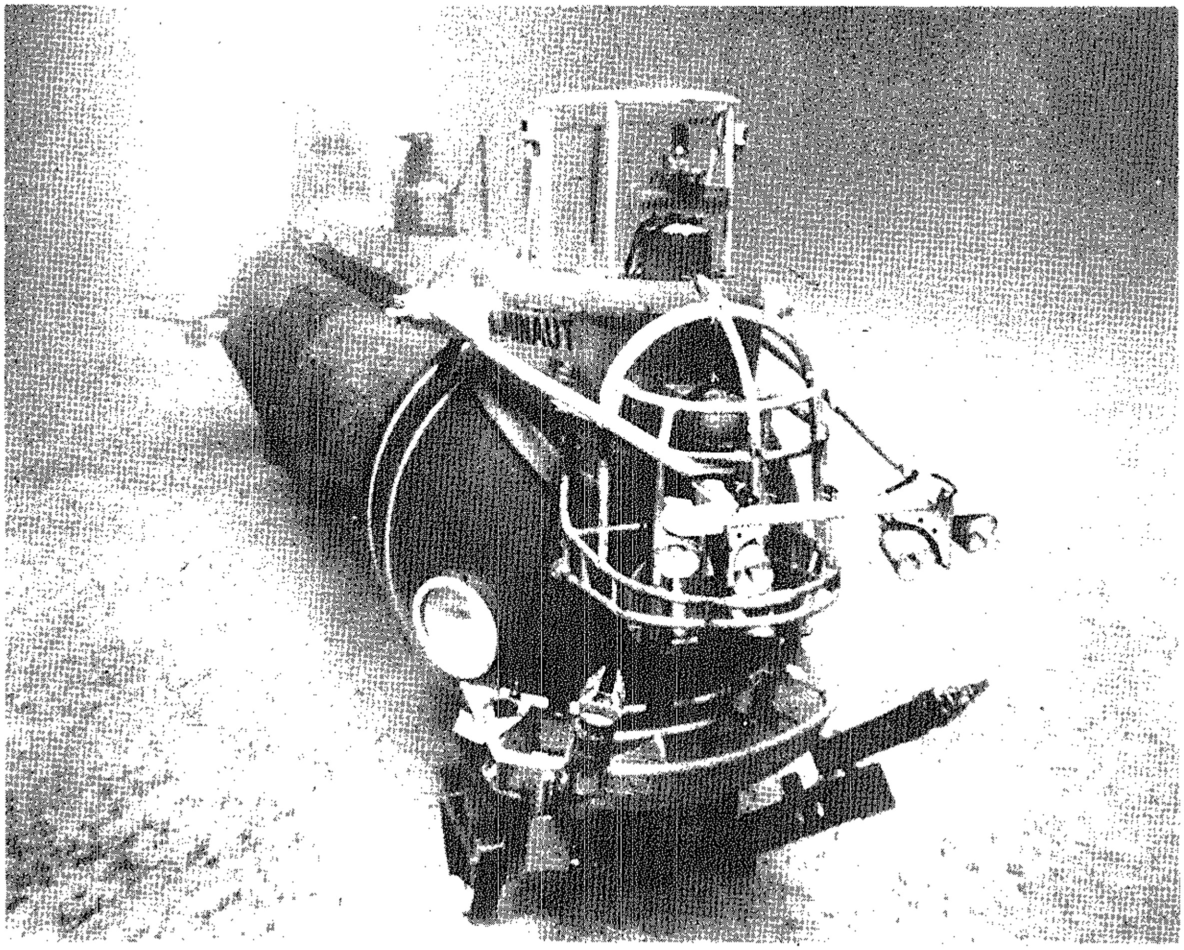
If ALVIN could be recovered, a third benefit would emerge. The vehicle had been submerged in a deep ocean environment for several months. Studies of her materiels and equipment promised to provide information on their behavior in such an environment which would otherwise be unavailable.

SELECTION OF VESSELS FOR THE SALVAGE FORCE

DRV ALUMINAUT – Manned Submersible

ALVIN planners considered the use of tethered devices such as CURV for attaching lift lines to ALVIN. However, these were soon ruled out in favor of manned submersibles. The latter were considered superior because they could take a recovery line down to ALVIN rather than relying on surface placement in the vicinity of the wreck as was the case with tethered devices. DRV ALUMINAUT, a manned, deep-diving submersible owned by Reynolds Submarine Service Corporation, was selected for the operation. She had the capability of executing the entire operation essentially as a self-contained unit, being capable of carrying the recovery line and lifting devices to the bottom and attaching the devices to ALVIN with her two manipulators. In addition, she was available for immediate operations.

ALUMINAUT, with an 81-ton submerged displacement, is a submarine laboratory capable of carrying three or four passengers in addition to her operating crew of three or four men. She has a scientific instrumentation payload of 6000 pounds with an average speed of 2.5 knots for dive durations up to 30 hours. Her design depth is 15,000 feet with a safety factor of 1.5.



ALUMINAUT, with her design depth of 15,000 feet, dive endurance of up to 30 hours and two manipulators, offered unique capabilities for locating ALVIN and preparing her to lift to the surface.

DRV ALUMINAUT, THE REMARKABLE DEEP DIVING SUBMARINE SELECTED FOR ALVIN RECOVERY OPERATIONS

USNS MIZAR (T-AGOR-11) – Command and Lift Ship

MIZAR, operated by the Military Sealift Command for the Naval Research Laboratory, is configured to operate as a seaborne scientific research platform for oceanographic research. She had already gained fame by locating the hulls of the lost submarines, THRESHER and SCORPION. She had also combined her capabilities with ALVIN in the successful search and recovery of a hydrogen bomb off the coast of Spain.

MIZAR had several unique capabilities which led to her designation as the command ship and lifting platform for the ALVIN operation. She was equipped with computerized facilities for accurate navigating and tracking from prepositioned transponders. Her integrated system of instruments enabled her to place an acoustic marker on the ocean floor and then make a complete exploration of the surrounding area, using photographs simultaneously with other measurements such as magnetic strength and acoustic echoes. Her large, stable platform could accommodate a 50,000-pound-pull traction winch, and she could handle a large lift line. The ship could provide tiedown points for additional safety harnesses, nets, and straps placed on ALVIN once she had been raised to near the surface. Additionally, the ship could lift either over-the-side or through its center well.

Support Ships

The offshore supply boat, M/V STACEY TIDE, was selected as the support ship to tend ALUMINAUT, to track her position underwater, and to maintain position relative to a bottom transponder/pinger, which marked ALVIN's position.

The R/V CRAWFORD was designated to provide extra accommodations and back-up plotting and underwater telephone communications.

KEY ELEMENTS IN THE SALVAGE PLAN

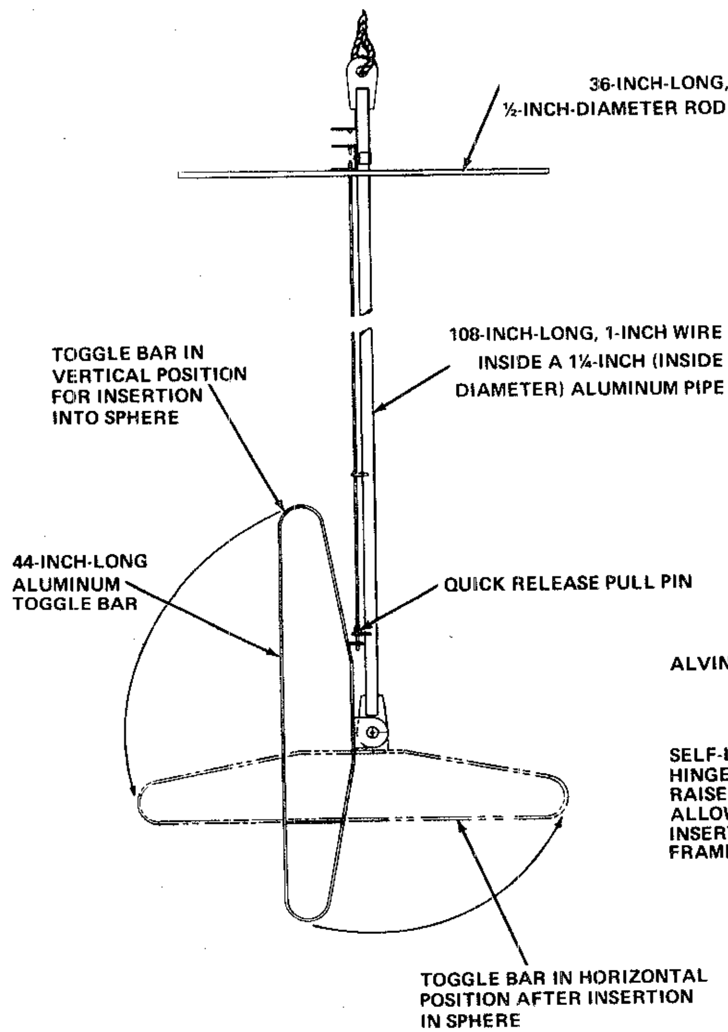
Six Steps in the Recovery of ALVIN

The salvage plan was simple in concept although it involved the application of sophisticated techniques. The operation was conceived as a series of six distinct steps:

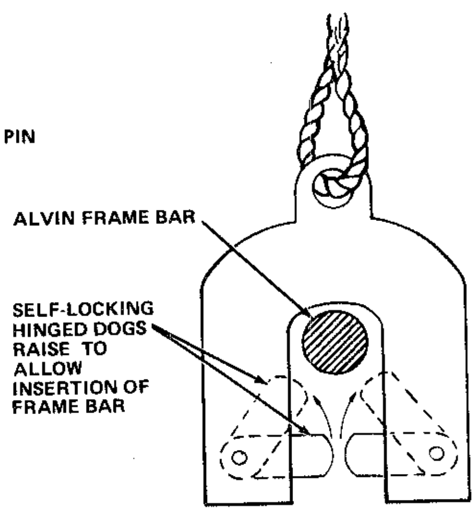
Relocating and marking
Attachment of lift lines
Lift to surface
Diver survey and attachment of safety lines
Tow to shallow water
Final lift and salvage

ALVIN's location would first be pinpointed with a transponder. MIZAR would maintain station over the sunken vehicle while ALUMINAUT would dive to the bottom, carrying the lift line mounted on a reel, a lifting bridle with attaching devices and a hatch opening device. In consideration of the depth and lift weights involved, a single piece of 4-1/2-inch Columbian double braided nylon Plimoor line with a nominal length of 7000 feet and a breaking strength of 35,000 pounds was selected as the primary lift line. Aided by computer calculations aboard MIZAR, ALUMINAUT would locate ALVIN using her Straza sonar to acquire and home in on the transponder which MIZAR had previously dropped close to the wreck.

After locating the sunken hull, ALUMINAUT would use its manipulators to attach the lifting devices to ALVIN. Two lifting devices were to be attached, forming a two-legged lifting bridle. One leg had a specially designed toggle for insertion into ALVIN's pressure sphere hatch. The other leg terminated in a stern hook, to be attached to ALVIN's stern lift fitting. Once the attachments were made, ALUMINAUT would surface slowly, paying out the lift line from the reel. After ALUMINAUT surfaced, the bitter end of the lift line would be transferred to MIZAR for handling and recovery.



TOGGLE BAR

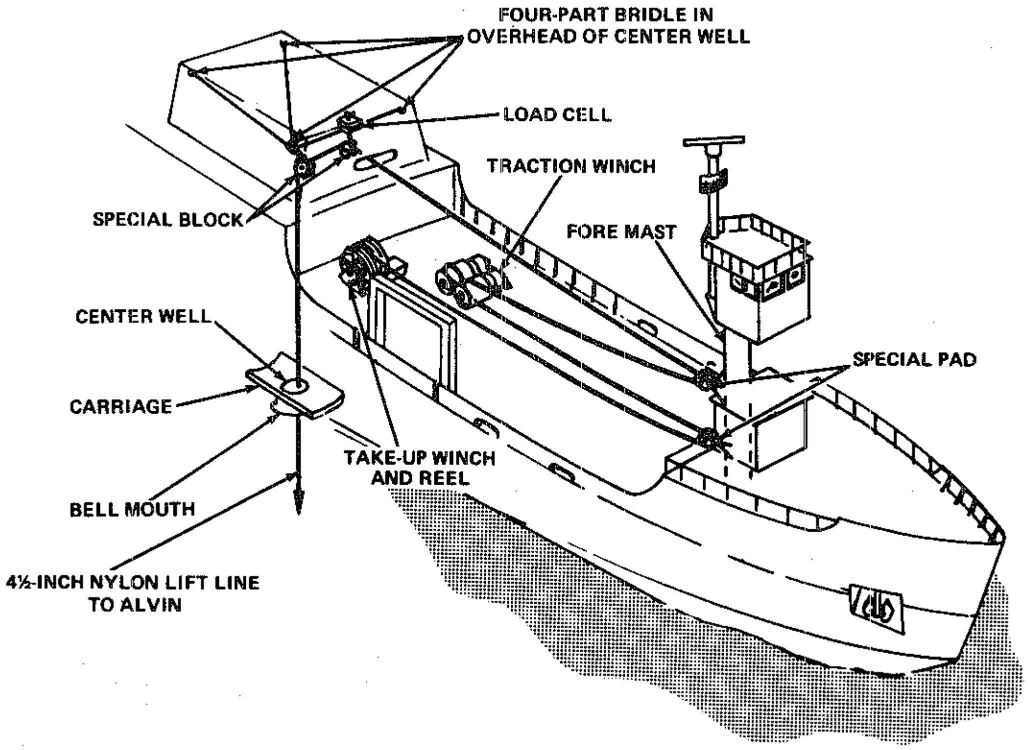


STERN HOOK

Salvors originally planned to make a two-point lift using these two devices. They redesigned the toggle bar after the initial unsuccessful lift attempt and switched to a one-point lift, eliminating use of the stern hook.

DEVICES FOR ATTACHING LIFT LINES TO ALVIN'S HULL

The plan called for rigging the lift line through a center well and winding it onto a traction winch. MIZAR would then haul the line in slowly until a steady force of 5000 pounds had been achieved; hauling would be stopped at this point to allow a gradual breakout. Once breakout had occurred, ALVIN would be lifted smoothly and continuously at a fixed speed of 35 feet per minute with loads and load surges being systematically recorded. Lifting would stop when ALVIN was 50–60 feet below MIZAR. At this point, divers were to survey ALVIN and secure a 1-inch wire pendant to the hull. The pendant was attached to a four-part bridle from MIZAR's center well. The load would then be shifted from the 4-1/2-inch lift line until the 1-inch wire exerted the primary support force.

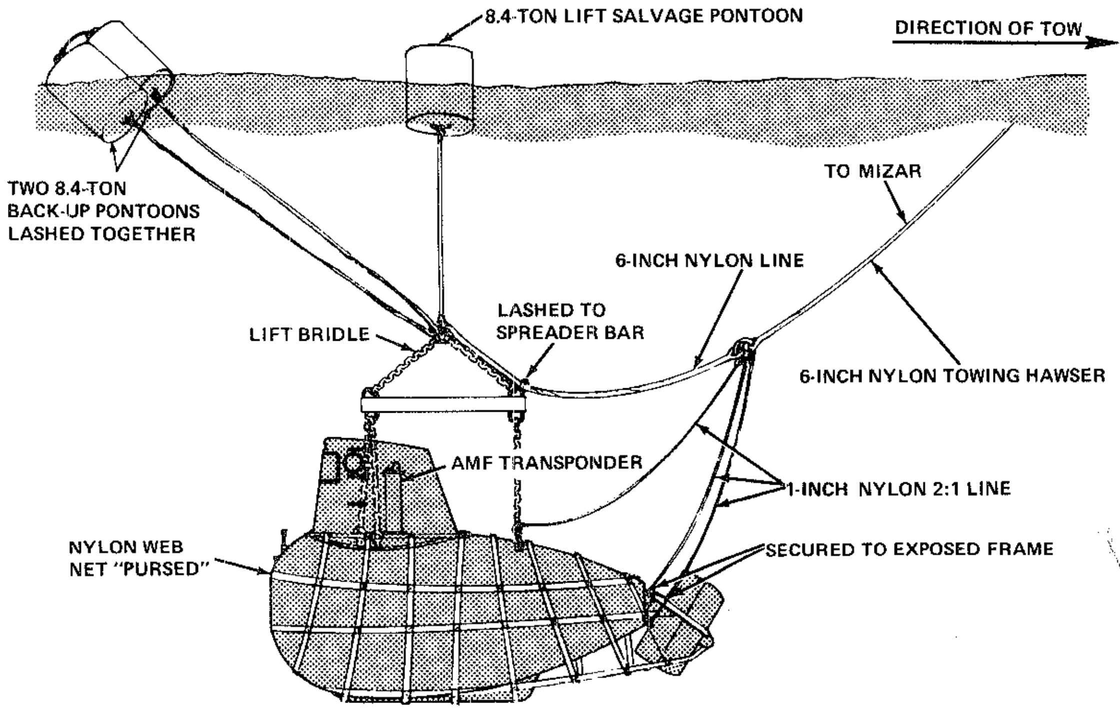


The basic salvage plan called for lifting ALVIN with rigging through MIZAR's center well. Studies demonstrated this method to be safer and more efficient than over-the-side lifting.

USNS MIZAR'S RIGGING FOR LIFT OF ALVIN

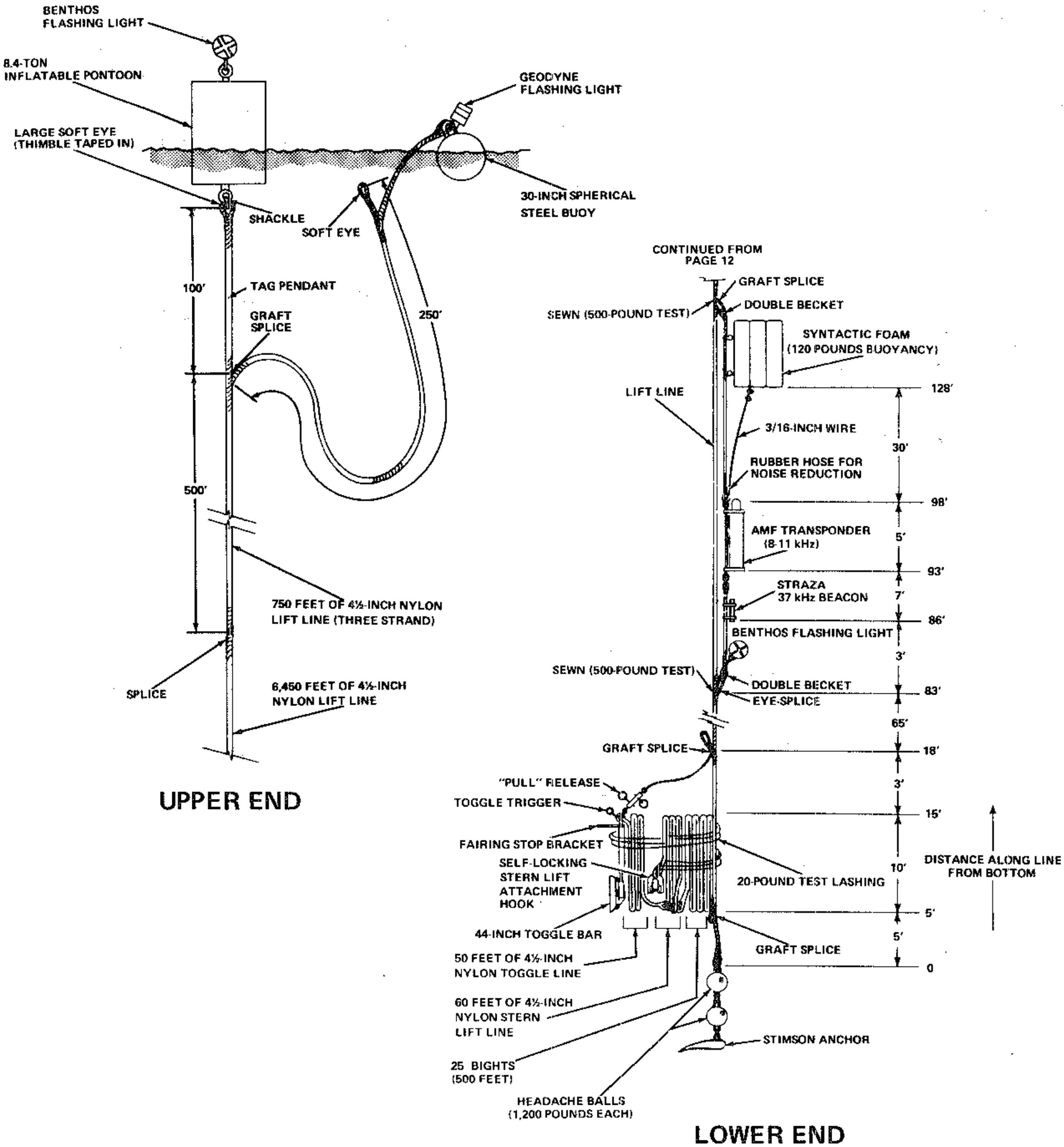
Actions would then be taken by the divers to increase buoyancy and lighten ALVIN. Safety slings would be attached to ALVIN and a prefabricated nylon web net would be wrapped around the hull. A 37 kHz pinger would also be strapped to the hull to ensure relocation should a catastrophic failure occur. ALVIN would then be rigged with a towing bridle from the foredeck of MIZAR in order to maintain proper towing attitude while underway.

MIZAR would next tow ALVIN, still submerged, to shallow water and set her down on the bottom for attachment of a new lifting rig using MIZAR's U-frame. ALVIN would then be lifted to the surface where her pressure sphere would be dewatered and the ballast blown. She then would be placed in a cradle for tow on the surface to Woods Hole. Upon arrival in port she was to be lifted from the water. Measures would be taken immediately to prevent corrosion of her components. Finally, effects of the prolonged submergence upon her systems would be studied.



Consideration was given to towing ALVIN, after the lift from the bottom, while suspended through MIZAR's center well. A surface tow was also considered. The plan shown here, which entailed suspending ALVIN from pontoons and towing her astern of MIZAR, was adopted because it was the most flexible and efficient method.

PLAN FOR TOWING ALVIN TO SHALLOW, PROTECTED WATER



Calculations of dynamic loads and stress provided the theoretical foundation for selecting and assembling the line. The wide variety of attachments and devices illustrates the ingenuity and careful attention to detail that characterized ALVIN salvage planning.

COMPONENTS OF LIFT LINE ASSEMBLED FOR RECOVERY

Provisions for Alternative Actions

Flexibility was an essential element of the plan. It was to be achieved by making provisions for alternative actions should any of the primary actions associated with each step of the plan prove ineffective or unfeasible. For example, if the computer aboard MIZAR did not work, the tracking team would employ an additional transponder to compute MIZAR's position relative to the bottom markers by use of a multiple-range system. The team would then conn ALUMINAUT toward the wreck site until she acquired ALVIN's hull and the transponder on her sonar.

Alternative methods were also planned for both lowering the lift line and attaching it to ALVIN. The alternative method of lowering the lift line called for it to be transferred to MIZAR for lowering. The salvors could not be certain that ALVIN's sail and pressure sphere hatches were open or, if closed, could be opened by ALUMINAUT. Accordingly, ALUMINAUT was to be prepared to attach a lift line to ALVIN's hull and marry it to the main lift line should it be impossible to insert the toggle through the hatches. Two back-up lift lines were provided should the primary lift line of 4-1/2-inch Columbian double-braided nylon prove inadequate.

Alternative actions such as the foregoing were built into each step of the primary plan wherever possible. Provisions were made, for example, to lower the lift line and bridle from MIZAR should the primary method of carrying this equipment to the wreck site aboard ALUMINAUT prove impractical. Several different navigation plans were prepared in substantial detail, providing for various contingencies in the task of locating and marking ALVIN. Capabilities for on-site repair and modification of devices such as the toggle to be inserted into the vehicle's hatch were provided for; and consideration was given in planning to various methods of rigging ALVIN for either surface or submerged tow once it had been raised from the bottom.

Thoroughness in Planning

The water depth and lift weight were important factors in determining the type of lift line, the recovery device, the surface support ship and the lift ship that could be used. ALVIN, with a weight of 31,500 pounds in air, was estimated to weigh 8800 pounds in water with her sphere flooded, assuming that the syntactic foam was still fully effective. It was expected that some buoyancy would be lost through water permeation of the syntactic foam during its long exposure at elevated pressures. However, there was neither experience nor data available on the effects of prolonged submergence. Bottom breakout forces were expected to be as high as 25 percent of ALVIN's in-water weight, with a gradual breakout prudent and probably essential.

The Naval Ship Engineering Center (NAVSEC) conducted detailed studies at the request of the Supervisor of Salvage to analyze the primary plan of using 4-1/2-inch Columbian nylon Plimoor line to lift ALVIN through 5000 feet of water. These studies exemplified the extraordinary thoroughness which featured salvage planning for ALVIN's recovery. ALVIN and the nylon rope would, in effect, form a spring-mass system. There was concern that dynamic resonance might be generated during the lift by ship motion exciting the spring-mass system.

These studies, which encompassed four different combinations of lines and methods of securing them aboard MIZAR, confirmed that the 4-1/2-inch Plimoor rope would be suitable for lifting ALVIN in sea states less than 3. The need for load cells (tensiometers) in the rope systems to continuously monitor the lift load was also revealed. The studies also pointed out the danger of resonance conditions developing near the surface where the lift line length would be less than 200 feet.

The Naval Research Laboratory also conducted studies to determine static and dynamic loads generated by ship's motions for the primary and the two back-up lift lines. Calculations were made, using a computer, for retrieval of a mass through the center well of a ship such as MIZAR as compared with retrieval over the side. Lifting through the center well was determined to be the safer mode.

Development of the equipment list for the operation was also characterized by thorough planning and meticulous attention to detail. A toggle, made of 2-inch aluminum plate, was designed and fabricated; it was contoured to fit ALVIN's sphere so as to maximize the area of contact and minimize local stresses. A stern hook was specially designed with hinged dogs which would lock automatically as the hook was positioned over ALVIN's frame bar. A double traction winch, each drum powered separately by a synchronous 10-hp motor through a reduction gear and chain drive, was installed aboard MIZAR for use as the recovery winch. Standard B. F. Goodrich inflatable rubber pontoons rated at 8.4-ton buoyancy lift were also to be used to suspend and mark the bitter end of the lift line and to support ALVIN during the tow to shallow water.

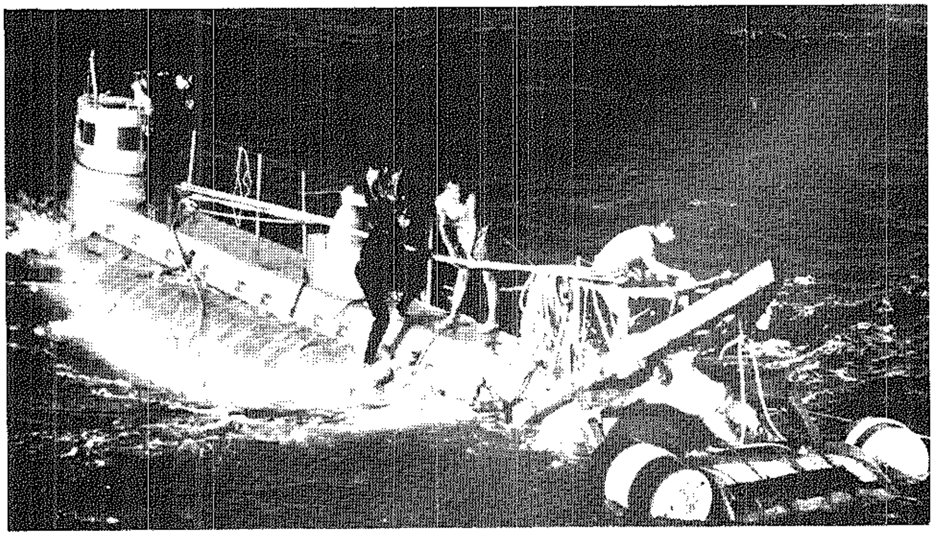
CONDUCT OF SALVAGE OPERATIONS

Implementation of Alternate Plans

MIZAR, after outfitting at Boston Naval Shipyard, deployed to the wreck site and commenced bathymetric and photographic runs on 13 August to positively locate ALVIN. After two unsuccessful camera runs, MIZAR's camera-carrying vehicle obtained a photograph of ALVIN on 15 August. The photograph, in addition to verifying ALVIN's location, also showed that she was not embedded in the ocean's bottom further than previously thought.

Meanwhile, STACEY TIDE and ALUMINAUT were conducting rehearsals at Provincetown. A wooden A-frame was installed on ALUMINAUT's bow to reduce the difficulty of handling the lift line and reel. The two vessels closed the salvage site late on 16 August and resumed the difficult task of mounting the reel and attaching the lift line the following morning. Rough seas with 5- to 7-foot swells and 20-knot winds hampered these operations and eventually caused severe damage to the reel and other equipment. This led to a decision at noon on 17 August to implement the alternate plan for lowering the line.

The alternate plan called for MIZAR to lower a recovery clump with an AMF transponder in the line. MIZAR would position the clump near ALVIN using three-dimensional tracking. ALUMINAUT, after locating ALVIN and the clump, would remove the toggle from the clump, attach it to ALVIN and then secure it to the suspended lift line.



Rehearsals showed this method of carrying the lift line to be unsound. An alternate plan was implemented in which the lift line was suspended from the surface; ALUMINAUT then secured it to the lifting device on ALVIN.

ALUMINAUT, WITH LIFT LINE AND REEL MOUNTED ON BOW

Unsuccessful Lift Attempt, 18–20 August

Worsening weather and the anticipated effects of Hurricane Camille dictated that a round-the-clock effort be made to rig MIZAR and prepare ALUMINAUT for diving. The lift line was anchored by a clump of syntactic foam block of 120-pound buoyancy. Other equipment making up the line included an AMF transponder, a Straza beacon, a Benthos flashing light, an aluminum toggle bar and a special stern hook. Two 1200-pound steel balls and a Stimson anchor were added to this assembly for holding position on the bottom.

MIZAR succeeded in lowering the clump on her third attempt late on 18 August. Using her computer and the transponder on the lift line, MIZAR maneuvered above ALVIN and placed the clump within 100 yards of the sunken hull. It required two and one-half hours of "flying" the clump to position it properly on the bottom.

ALUMINAUT then dove to find ALVIN and the clump. Although her Straza sonar failed, she was successfully directed to within visual range of ALVIN by MIZAR. Clouds of fine silt hampered observation. However, ALUMINAUT was able to confirm that ALVIN was still intact except for her damaged stern area and that her pressure sphere hatch was open and unobstructed. She next went in search of the clump, finding it without difficulty.

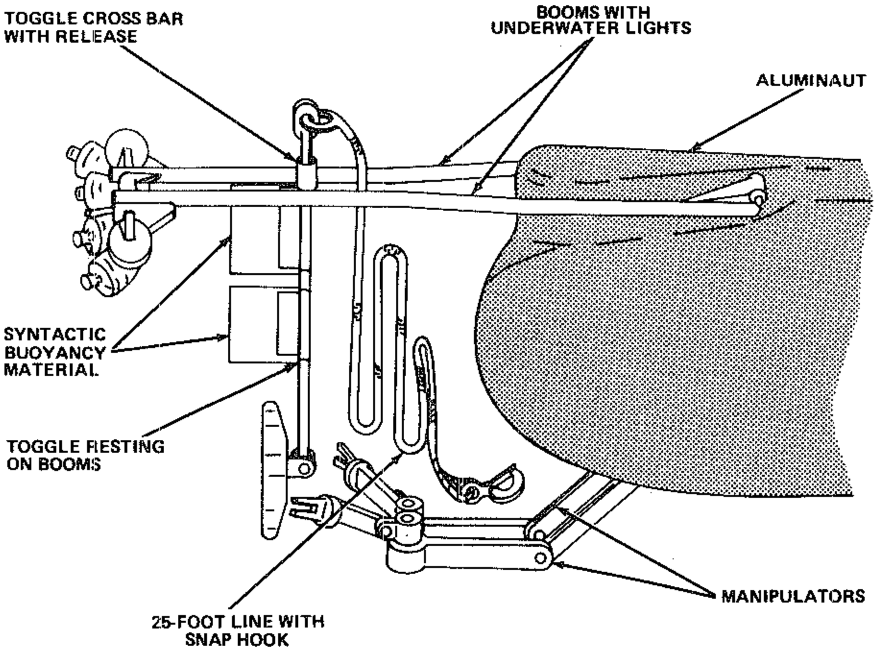
After locating the clump, ALUMINAUT pulled the toggle away from the clump and carried it to ALVIN where she attempted to insert the toggle bar into the open hatch. This effort failed despite repeated attempts over a period of several hours. ALUMINAUT's maneuverability was limited because her vertical motion motor had failed. A line leading from the end of the toggle became fouled, upsetting the toggle's balance. Buoyancy materiel, attached to the toggle, broke free, changing its balance point and making it more difficult to handle. ALUMINAUT returned to the surface early on 19 August, having expended all battery and life support system endurance.

Heavy seas made it impossible for ALUMINAUT to recharge her batteries at the recovery site. For this reason, and because Camille's side effects were producing worsening weather in the operating area, the salvage force retired to Woods Hole, arriving there early on 20 August. The lift line, with pontoon and watch buoy attached to its bitter end, was left in place. Despite the obstacles of weather and technical difficulties, the force was confident that, with a properly operating submersible, it would be able to retrieve ALVIN on the next attempt.

Recovery of ALVIN, 27 August – 1 September

ALUMINAUT was sent to Boston Naval Shipyard where repairs were made to a malfunctioning manipulator. Because the original pendant holding the toggle was fouled on ALVIN, an alternate method of placing the primary lift device was prepared. A new toggle bar was built, with a 25-foot nylon pendant attached to it. The pendant had a snap hook on the tag end which was to be snapped onto the ring at the lower end of the lift line.

Visual inspection of the joint between ALVIN's fore- and after-bodies had revealed that it was in excellent condition. A one-point lift, using the toggle as the only lifting device, was therefore adopted in lieu of the two-point lift originally planned. As before, ALUMINAUT would use her manipulators to lower the toggle bar into ALVIN's hatch and trip the holding pin so that the bar would swing perpendicular to the hatch and become securely lodged. She would then grasp the tag end of the toggle line and snap it into the lift line ring.



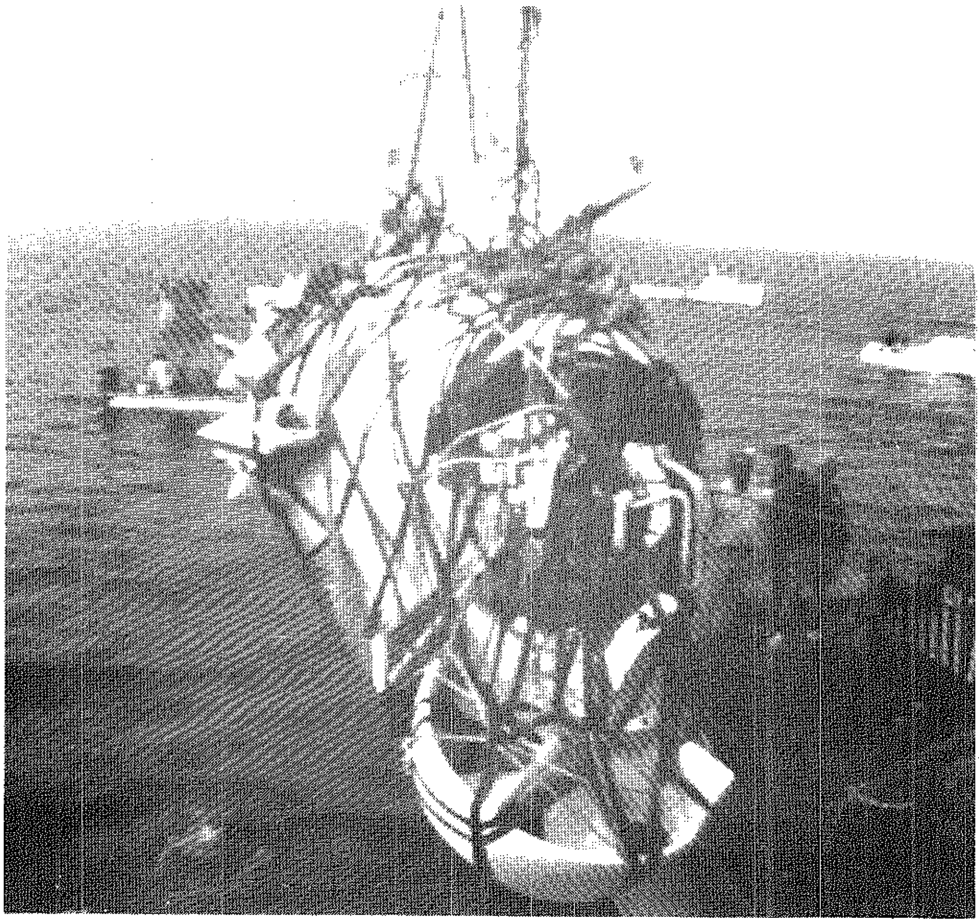
After the initial unsuccessful lift attempt salvors redesigned the toggle and devised this scheme for carrying it aboard ALUMINAUT. ALUMINAUT could use one manipulator to hold onto ALVIN and the other to maneuver the toggle into ALVIN's pressure sphere.

CARRYING OF TOGGLE ON ALUMINAUT'S FLOODLIGHT BOOMS

The task force assembled once again at the recovery site on 27 August. ALUMINAUT dove to engage ALVIN. A submerged transit of five hours was necessary before she could report that ALVIN was on her starboard bow. She then began efforts to insert the toggle bar into ALVIN's hatch. It was finally inserted after several unsuccessful attempts. ALUMINAUT had to tear away part of ALVIN's fiberglass sail with her manipulators in order to properly position the toggle. She attached the toggle line to the lift line and then tugged on the lift line using her vertical lift propulsion system. The line held, indicating that the toggle was firmly emplaced. The versatile manned submersible surfaced early on 28 August after a prolonged but successful dive of almost 17 hours.

MIZAR commenced lifting ALVIN shortly thereafter. No appreciable breakout was encountered and lifting proceeded smoothly and without incident. As items such as the syntactic foam block, AMF transponder, Benthos light, steel balls and Stimson anchor came to the surface, they were removed from the lift line and stayed off for later recovery. Divers inspected ALVIN at a depth of 100 feet and attached her regular lifting bridle. She was then raised to a depth of 30 feet where divers completed rigging and other preparations for towing. MIZAR then attempted to float ALVIN. However, leaks in the main ballast tanks prevented blowing them dry. The toggle bar, jammed in the hatch, also precluded dewatering the pressure sphere. Accordingly she was rigged for submerged tow, a protective nylon net being wrapped around her hull to prevent loss of any parts.

The towing method selected involved suspending ALVIN at a depth of 40 feet from pontoons. This would permit passage to sheltered, shallow waters for final lift onto a barge. ALVIN was towed backward firmly secured to three 8.4-ton inflatable salvage pontoons. MIZAR began the passage to protected waters early on 29 August at a speed of two knots with the tow streamed 350 feet astern. During the tow, one pontoon deflated and a second began to deflate. An additional pontoon was attached and two reserve pontoons were made ready aboard MIZAR. Otherwise, the passage was made without incident. ALVIN was lifted aboard a barge on 1 September, towed to Woods Hole and delivered to a representative of the Office of Naval Research.



The salvage site was 100 miles into the North Atlantic. The task force conducted a submerged tow over a period of four days to rendezvous with the barge in protected waters for the last leg of ALVIN's long voyage home.

CULMINATION OF SALVAGE OPERATIONS . . .

ALVIN BEING LIFTED ABOARD BARGE FOR RETURN TO WOODS HOLE

CONCLUSIONS

Plans for underwater work in the deep ocean environment must be simple and flexible. This environment is fundamentally alien and hostile and can easily defeat attempts to accomplish complicated schemes. Few plans, even though they may be simple and straightforward, can be executed precisely as conceived. They therefore must be easy to modify as required to meet the various contingencies which inevitably arise. Plans for ALVIN's recovery featured both of these essential characteristics.

ALVIN plans, although simple and flexible, were also developed in exceptional detail. There is an important lesson involved in this apparent paradox. Detailed plans are often equated to complicated and rigid plans. The truth of the matter, however, is that simplicity and flexibility emerge as products of detailed planning and are rarely achieved without it. It is the meticulous attention to detail in the development of alternative concepts and examining their feasibility that produces a simple and therefore effective plan for salvage operations. The process involved is not unlike that of arriving at an elegant solution through scientific experiment.

Rehearsals are always useful and are normally an essential step in preparing for a salvage operation. They are critical if new, unproven techniques are to be employed. They provide an opportunity to train personnel as well as to validate techniques. The ALVIN rehearsals led to a decision to modify the plan for lowering the lift line as a result of difficulties encountered in mounting the line on ALUMINAUT. Rehearsals are sometimes bypassed in salvage operations because of the operational need to get the operation underway as soon as possible. The decision to forego a rehearsal must be carefully weighed in light of its possible consequences on the efficiency of executing the operation.

As is the case with salvage plans, equipment and systems for underwater work must be simple if they are to be effective. They should also be proven through pre-operational testing and experiment wherever possible. Generally, complex or unproven equipment or techniques should be employed only when no other course of action is available. Mounting the reel and lift line on ALUMINAUT was an unproven technique. It was also complicated in that it was conducted on the water's surface, illustrating once again that actions of this type should be performed on deck or submerged so as to avoid the adverse effects of the air-water interface.

The ALVIN operation involved the participation of many diverse activities, civilian as well as Naval. It is to be expected that salvage operations of this scope and difficulty will require the application of various skills and capabilities which can only be marshaled from several different sources. Integrating such diverse activities into an efficient operating force is a formidable leadership task which can be accomplished only with cooperation and free flow of information among all participants. Energetic, effective leadership of the ALVIN task force and the dedication of all its members were ingredients that were just as vital to the successful recovery as technical competence and materiel resources.

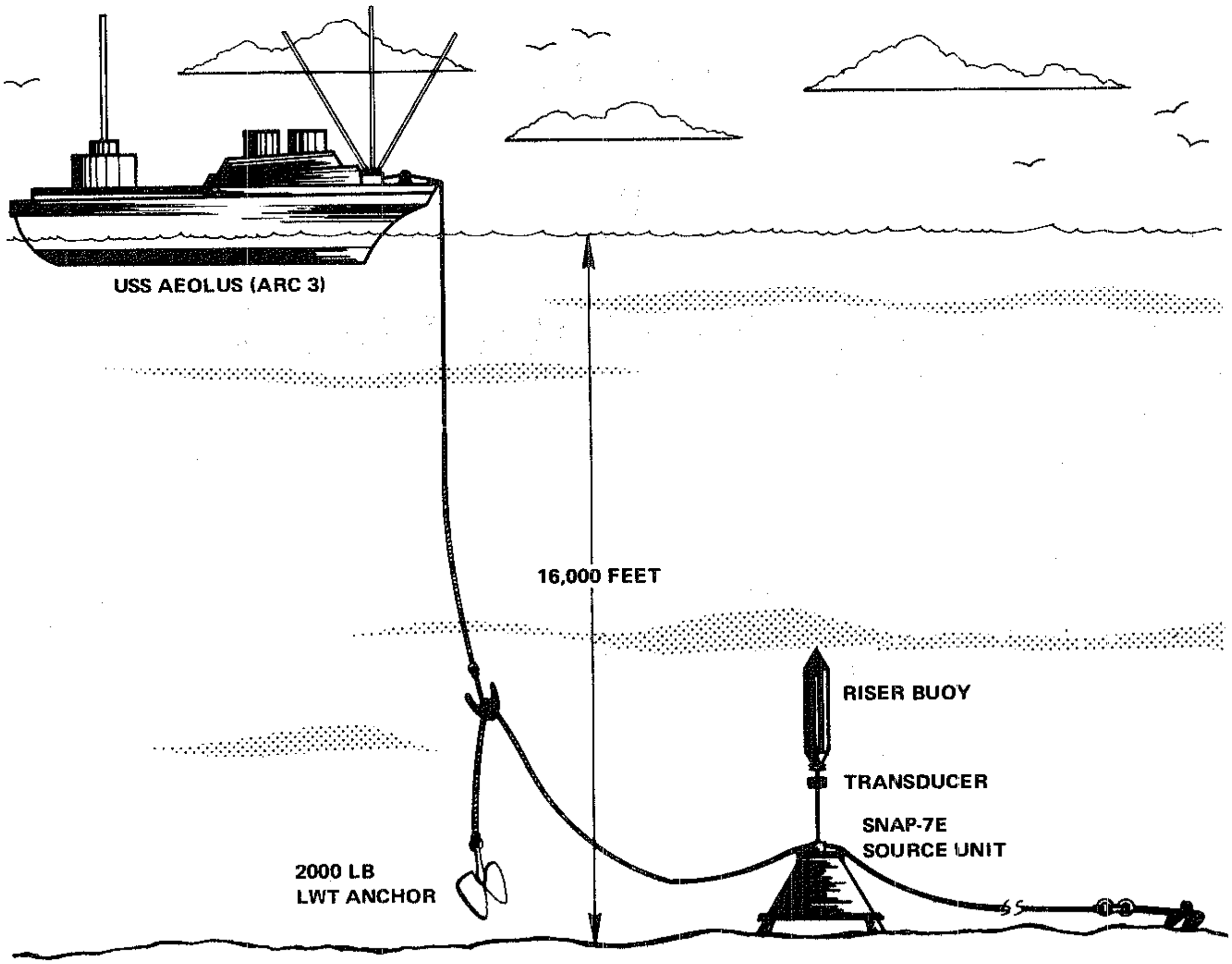
ALUMINAUT made a decisive contribution to the recovery effort, demonstrating anew the potential of manned submersibles in accomplishing underwater work at great depths. The presence of men at the recovery site was crucial even though the actual work was performed entirely by machines. They were able to provide crucial information to the salvage command headquarters afloat and take the necessary action to modify plans when required.

The significance of the ALVIN operation lies not only in the recovery of a valuable research vehicle but also in the wealth of experience gained in applying and demonstrating the Navy's capabilities to perform underwater work in the deep ocean environment.

RECOVERY

OF

IMPLANTED ACOUSTICAL BEACON SNAP-7E



The USS AEOLUS recovered the SNAP-7E, an implanted acoustical beacon by grappling its anchor line on the ocean floor and then lifting the unit to the surface. The operation was particularly significant because of the great depth involved.

THE RECOVERY OF SNAP-7E

RECOVERY OF IMPLANTED ACOUSTICAL BEACON
SNAP-7E

INTRODUCTION

SNAP-7E is one of a series of acoustical beacons constructed by the Atomic Energy Commission for Navy experimental work in underwater sound transmission. The beacon had been implanted on the ocean floor off Bermuda in 1964. After operating successfully for several years, it ceased functioning in October 1968. The Atomic Energy Commission requested the Supervisor of Salvage to recover the device in order that it could be examined to determine the cause of failure. The request was followed promptly by full-scale recovery operations beginning on 23 November 1969.

Retrieval posed unique problems because the device had been implanted at the unprecedented depth of 16,000 feet. It was accomplished by grappling in a remarkable salvage effort which required less than four days. The recovery plan, developed by the Office of the Supervisor of Salvage, fully exploited the capabilities of the USS AEOLUS (ARC 3), a cable repairing ship provided by COMSERVLANT for the operation.

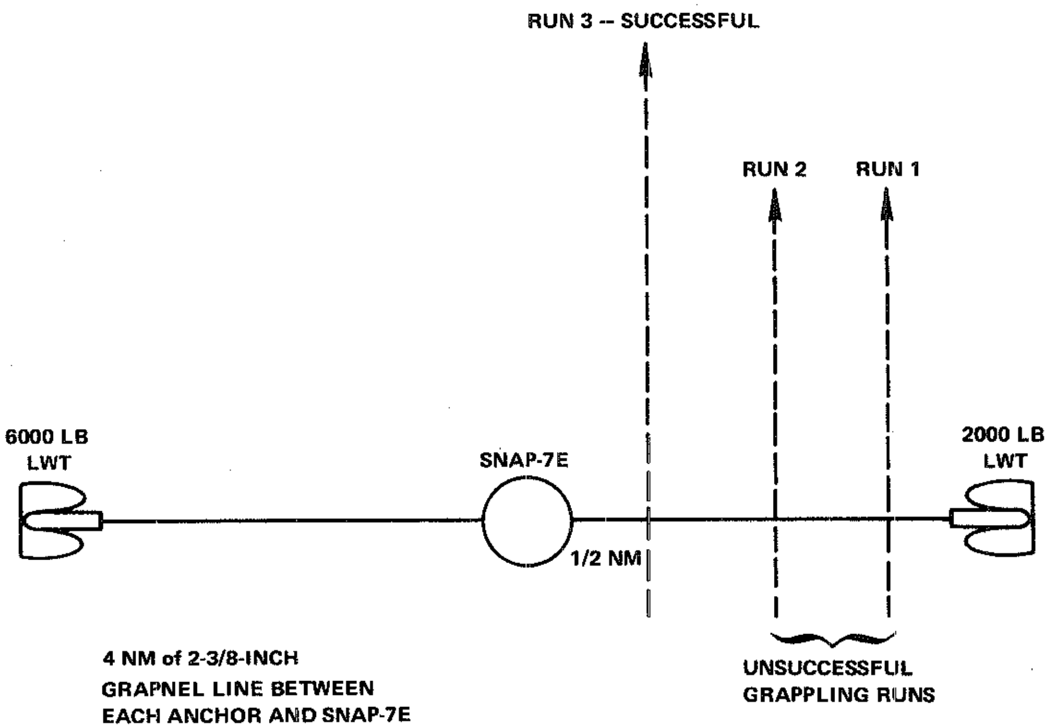
THE RECOVERY PLAN

AEOLUS was ideally suited to serve as the recovery platform. It had implanted the array originally and had aboard all the grappling, winching and related equipment that would be needed for the recovery effort. In addition, her crew was well-trained in the seamanship of cable handling.

The SNAP-7E had originally been lowered to the ocean floor in a catenary arrangement using two light-weight type (LWT) anchors, one of 6000 pounds and the other of 2000 pounds. Each catenary leg was composed of about four miles of 2-5/8-inch grapnel line connected to the SNAP-7E frame by a 30-foot length of 1-1/2-inch di-lok chain. The heavier anchor had been lowered first and the recovery force was reasonably sure of its position. It was not as certain of the position of the 2000-pound anchor. It was conceivable that this anchor was considerably closer to the SNAP-7E unit than four miles, with resulting bends and twists in the anchor line.

Both anchor lines offered an opportunity for grappling. The 2000-pound anchor, being the lighter, would break away from the bottom more easily. Accordingly, its anchor line was selected as the primary target for grappling runs. The line to the 6000-pound anchor was to be used as an alternate in the event that operations to pick up the first line did not succeed.

Since the position of the 2000-pound anchor could not be firmly established, it was planned to make the first grappling run at a distance of three miles from the SNAP-7E unit. If this did not engage the anchor line, then subsequent runs would be made progressively closer to the unit. This systematic approach would ensure making contact as close to the anchor as possible, facilitating control and breakout.



The recovery concept was to engage the grapnel line near the lighter anchor. Its position was not accurately known. Grappling runs were therefore made progressively closer to the SNAP-7E unit.

GRAPPLING RUNS FOR RECOVERY OF SNAP-7E

The actual materiel weight to be lifted was less than 23 tons. The salvors anticipated, however, that the tensions produced in the lifting operation would far exceed this figure. Calculations of the forces involved led to the selection of 2-5/8-inch grapnel line as the primary lifting line. This line, with a breaking strength of 105,000 pounds, was strong enough to withstand the maximum tensions expected. Only 2700 fathoms of the 2-5/8-inch grapnel line were available whereas some 3400 fathoms would be needed to ensure effective dragging on the ocean floor at the great depth involved. The balance was made up by attaching 1-5/8-inch grapnel line on the final leg of the payout. Use of this lighter line would not compromise the integrity of the overall line as it would be hauled in long before the area of maximum tensions near the surface was reached during the actual lift.

The grappling rig, itself, was made up of one leading set of light Gifford grapnels and two trailing sets of heavy Gifford grapnels. These were secured to the lift line with a 10-fathom shot of 1-1/4-inch chain. A set of heavy Rennie grapnels was held in reserve for use if needed.

After pickup and lifting, the SNAP-7E would not be brought aboard the AEOLUS immediately. Initially, it would be suspended above the surface where it would be tested for radiation leaks. If it were safe to proceed, the riser cable would be cut and the transducer and buoy would be retrieved. The anchor lines would then be cut and the SNAP-7E unit hoisted aboard the AEOLUS and made secure. Retrieval of the anchors would follow these operations.

RECOVERY OPERATIONS

Two Attempts Fail to Make Contact

The first grappling run was made at 0120 on 23 November following six hours of work in paying out the required 3400 fathoms of grapnel line. At 0220, having gone well past the assumed location of the mooring cable and with no increase in tension registering on the dynamometer, AEOLUS terminated this first run. She then made a second try in the same direction but at a point one mile closer to the SNAP-7E unit. This attempt also failed to engage the mooring cable.

The salvors suspected that the grapnels were not functioning properly. There was no doubt, given the amount of line that had been paid out, that they were dragging along the ocean floor. However, observation of the dynamometer did not indicate the abrupt and brief changes in readings associated with the normal temporary snagging of small objects. Accordingly it was decided to haul in the grapnels for inspection, accepting the delays entailed in retrieving the long lifting line. Inhaul was completed about 1600.

The inspection revealed that the small lead set of Gifford grapnels had tumbled. The two trailing sets appeared to be functioning properly. The condition was corrected. A set of heavy Rennie grapnels was added to the rig as a precautionary measure, primarily to provide heavier weight. A 500-foot section of the 2-5/8-inch grapnel line was also removed during this interval as it showed evidence of excessive wear. The remaining length of this heavy line was still more than adequate to provide the necessary safety margin for subsequent lift attempts.

Third Grappling Run Succeeds

The recovery force turned to for the next attempt immediately following the inspection and modification to the grapnels and the inhaul line. Payout began at 1645 and was completed by 2100. AEOLUS began her run shortly thereafter at a speed of one knot, reducing speed to one-half knot as she passed over the plotted portion of the anchor line. Tension on the inhaul line read 23,000 pounds. As previously planned, the run was made to grapple the anchor line at a point one-half mile from the SNAP-7E unit.

Tension began rising steadily at 2155 with AEOLUS holding her course and speed. It rose to 27,000 pounds within 10 minutes. Line pickup was begun at a rate of 10 feet per minute. The tension increased to 35,000 pounds and it was clear that the grapnels had engaged the anchor line. AEOLUS then continued to maintain sufficient power to keep a strain on the grapnels, preventing premature disengagement while they were still on the ocean floor. The footage counter was observed closely as inhaul proceeded in order to determine when the grapnels cleared the bottom. This occurred about 2300. AEOLUS established her position for the remaining lift and cut her engines. Lifting then continued at an increased inhaul rate of 30 feet per minute. At 2355, some 2430 fathoms remained to be retrieved with tension registering 36,000 pounds on the dynamometer.

Completing the Lifting Operation

Tension rose steadily as inhaul continued, reaching 57,000 pounds at 0200, almost five hours after beginning the third run. About 1700 fathoms of line remained to be retrieved. The SNAP-7E unit had broken free from the bottom by this time and was well into its ascent to the surface.

The line force had risen steadily to 72,000 pounds by the following morning when the 750-fathom mark was reached. It was considered likely that the 2000-pound LWT anchor had taken hold. AEOLUS dragged it inward toward the 6000-pound LWT anchor to provide more slack line between the two anchors and, thus, to reduce tension. The maneuver succeeded in reducing the tension to 60,000 pounds.

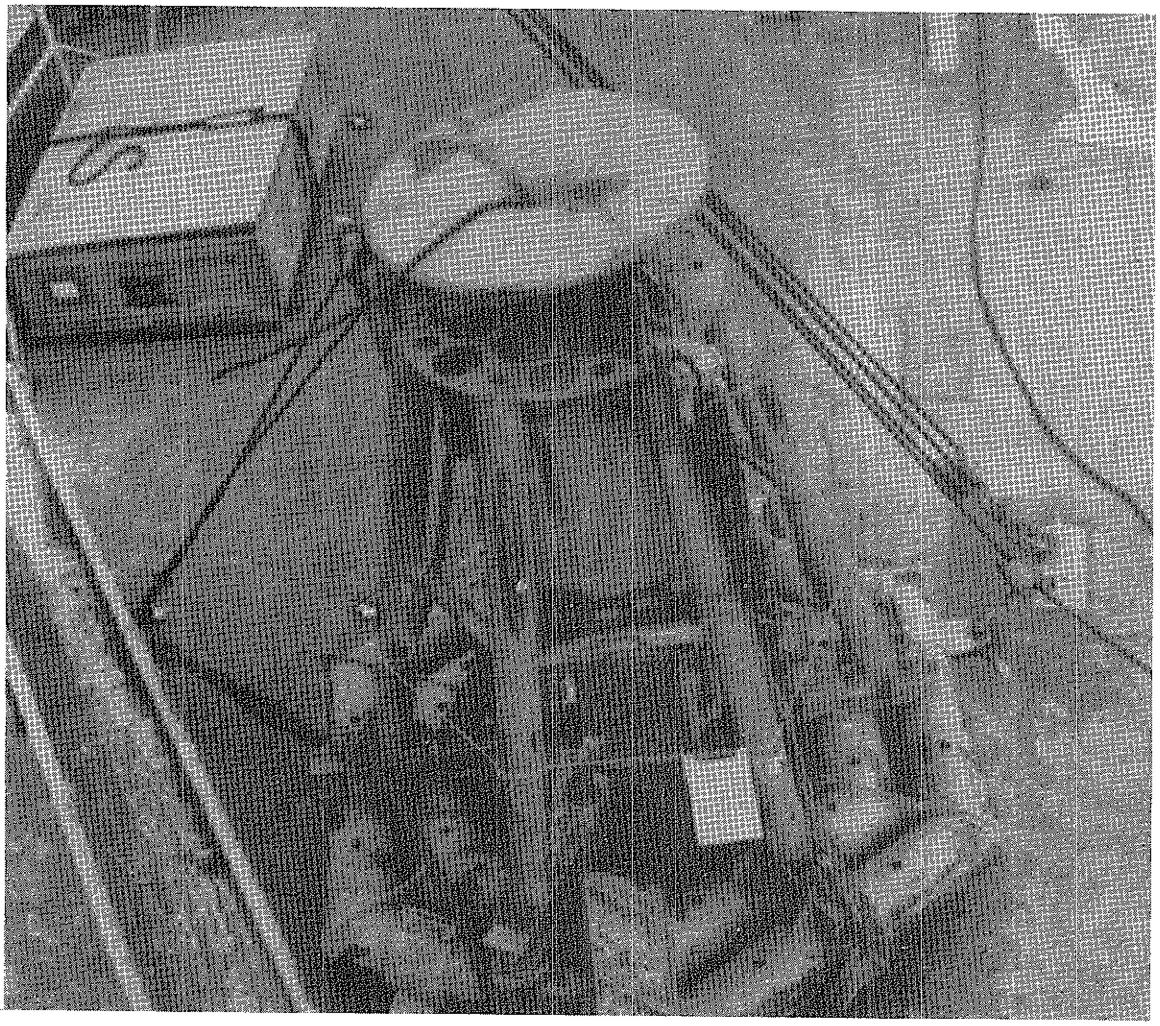
Dragging the smaller anchor was attempted again at the 250-fathom mark. However, the wind had picked up and swells began producing surges in the line force up to 80,000 pounds. Dragging was terminated and lifting resumed at an increased rate of 50 feet per minute. A third dragging maneuver was conducted successfully just before the chain and grapnels reached the surface late in the morning with heavy seas still running. The chain was stoppered after it passed over the bow sheave because tensions were reaching 84,000 pounds with one surge up to 104,000 pounds.

The bight of line holding the SNAP-7E device and the 2000-pound anchor was secured to the inhaul line with a Bell Telephone Laboratory stopper. The bight and stopper were then passed over the cable drum and through the holdback machine. Forces during this period reached 95,000 pounds. The bight was then severed and the resulting two lines were separated. The anchor line was connected to the port cable machine. The other, the SNAP-7E retrieval line, was connected to the starboard cable machine. Both lines were connected since the salvage force could not be certain at the time that it had identified the SNAP-7E retrieval line correctly.

Inhaul of the SNAP-7E retrieval line began at 1525. The device surfaced two hours later after 830 fathoms of line had been retrieved. Tensions remained near 45,000 pounds throughout this portion of the lift. A holdback machine was used in conjunction with the starboard cable machine to control the lift. As the SNAP-7E retrieval line passed through the holdback machine, its loose end was paid out over the side for disposal into the sea.

The device was raised clear of the surface and monitored for radiation hazards. It was found safe and operations to bring it aboard the AEOLUS proceeded. The anchor line that had been previously secured to the port cable machine was severed and disposed of in order to permit use of the cable machine for lift operations. An 8.4-ton pontoon was then secured to the SNAP-7E unit. Both the pontoon and the device were suspended above the surface during the attachment in order to avoid the danger of working in heavy seas. They were then lowered into the water and maneuvered to the starboard side of the ship, where hookup to a crane and lift aboard were accomplished quickly and easily. SNAP-7E was made secure on deck at 2215, climaxing 48 hours of sustained recovery operations.

The 6000-pound LWT anchor and its grapnel lines were retrieved early the following morning, 26 November, prior to departing the salvage site. The SNAP-7E transducer and riser buoy could not be recovered. Corrosion in the free end of the riser cable suggested that this cable had parted some time prior to the recovery attempt. The AEOLUS delivered the SNAP-7E and its associated equipment to NAVFAC authorities at Davisville, Rhode Island, a few days later, bringing to successful completion an historic salvage operation.



The SNAP-7E unit weighed five tons and stood 10 feet high. It was made well secure as shown for the return voyage to Rhode Island.

SNAP-7E ABOARD AEOLUS AFTER RECOVERY

CONCLUSIONS

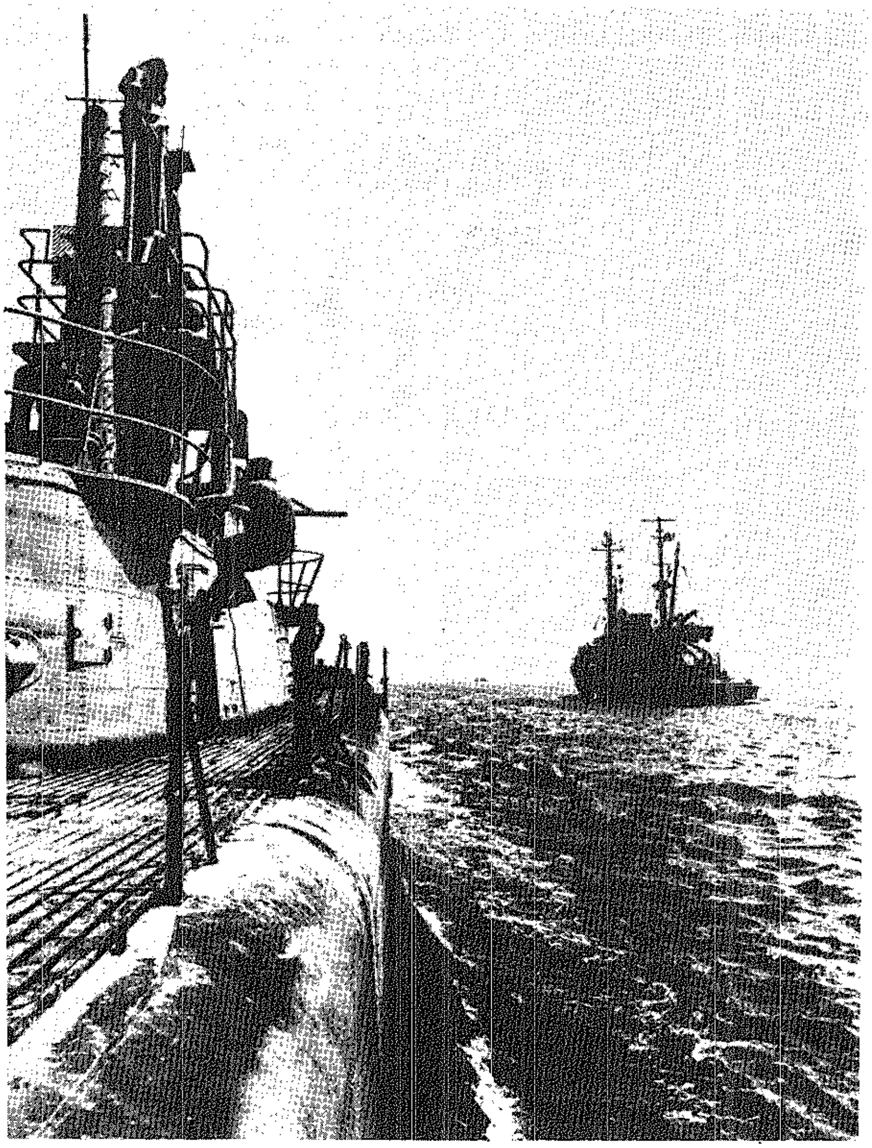
The recovery of SNAP-7E from water depths of about 16,000 feet closely followed the successful recovery of the Deep Research Vehicle ALVIN from depths of over 5000 feet. Taken together, these two accomplishments have added a new dimension to the U.S. Navy's capabilities for deep ocean search, location and recovery operations. The SNAP-7E recovery was a remarkable salvage effort in all respects, combining sound planning with expert and vigorous execution to reach down through incredible depths and recover an object from the ocean floor.

RECOVERY

OF

ex-USS HAKE

IN SUBSALVEX-69



Salvage forces of the Atlantic Fleet conducted this exercise in Chesapeake Bay. A submarine hull was towed to the exercise site and sunk. Two different lifts were made using submarine salvage pontoons.

SUBMARINE SALVAGE EXERCISE - SUBSALVEX 69

RECOVERY OF ex-USS HAKE IN SUBSALVEX-69

INTRODUCTION

The ex-USS HAKE was intentionally sunk in the Plantation Flats of the Chesapeake Bay by the U.S. Navy in May 1969 in water depths over 100 feet to provide needed salvage training and experience for personnel and to test the effectiveness of pontoon use in these types of operations. Not since 1939 had pontoons been utilized in attempts to raise a disabled, submerged submarine (we refer specifically, in this case, to the USS SQUALUS salvage operations), and a reexamination of this concept of rescue was long overdue. The salvage exercise planned for the ex-USS HAKE afforded an excellent opportunity to investigate and determine the extent of importance and/or value of these devices in such operations.

PLANNING AND PREPARATIONS

Preliminary Planning

Commander Service Squadron EIGHT (COMSERVRON EIGHT) developed the basic concept of the exercise. The concept called for two distinct recovery operations. In the first, ex-HAKE would be raised from a depth of about 100 feet using six submarine salvage pontoons (YSP's) rigged fore and aft in pairs, with a control pontoon for each pair. The submarine hull would then be re-bottomed for the second recovery operation in which it would be raised with six YSP's and selective blowing of ballast tanks.

The first lift was designed to be as simple as possible in view of the relative lack of experience in handling and rigging YSP's. The second was intended to be more difficult in that it featured the selective blowing of ballast tanks in conjunction with use of the YSP's. It was predicted that a lifting force of 450–500 tons would be required for the second recovery operation in contrast to a force of only 100 tons for the initial lift. The need for the increased lifting force was predicated on re-bottoming ex-HAKE by flooding two internal compartments in addition to ballast tanks.

A related feature of the exercise was to be the conduct of simulated submarine rescue operations by elements of Submarine Squadron Six (SUBRON SIX). These operations were to be conducted over a two-day period immediately following the initial bottoming of the ex-HAKE and prior to the beginning of the first salvage operation. They were to feature the employment of a McCann rescue chamber by USS PETREL (ASR-14) to inspect the sunken hull, simulating that survivors were aboard.

Detailed Planning

Detailed planning was conducted in March and April. The following key events for the exercise were identified. The actual dates of their execution, which are listed, varied only slightly from the pre-planned exercise schedule.

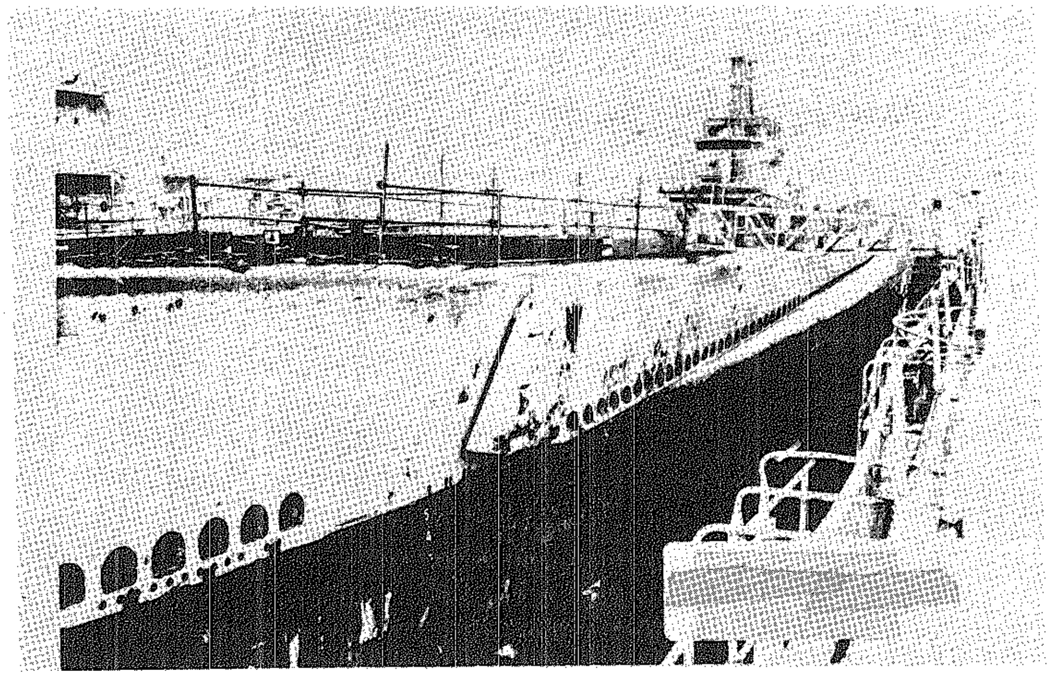
- 5 May – **Position and bottom ex-HAKE**
- 6–7 May – **Conduct submarine rescue operations**
- 7 May – **Position salvage ships in moor over ex-HAKE**
- 8 May – **Conduct underwater survey**
- 9–15 May – **Rig and position pontoons**
- 16–18 May – **First lift of ex-HAKE**
- 18 May – **Re-position and re-bottom ex-HAKE**
- 18–22 May – **Rig for second lift**
- 22 May – **Second lift**
- 23 May – **Return to port with ex-HAKE in tow**

A key change between preliminary plans and the final plans for the exercise concerned the number of YSP's to be used. Whereas it had been originally thought that six pontoons would be necessary, more refined calculations indicated that four would suffice. Two identical pairs of pontoons were to be rigged, one pair at the bow and a second pair at the stern of the submarine hull. Each pair was to be comprised of one 85-ton primary lift pontoon and one 80-ton control pontoon. The control pontoons were to be maintained at a depth of 40 feet as compared to ex-HAKE's depth of 108 feet.

Preparing ex-HAKE for the Exercise

It was determined that, even with all main and fuel ballast tanks flooded with sea water, ex-HAKE was too light to submerge. Since it had been decided that no compartments would be flooded, at least in the initial phase, the necessary additions in weight were made by placing concrete in the forward and after battery wells, reefer and magazine storage areas, and pump and after engine rooms. This additional weight increased ex-HAKE's surface displacement to 2074.4 tons. The hull's total submerged weight would be 2666.7 tons, including 592.3 tons of sea water in the main and fuel ballast tanks. Since ex-HAKE's normal displacement is 2428 tons, the net negative weight would be 238.7 tons. This net negative weight was considered optimum for a four-pontoon (YSP) lift of 330 tons.

Other preparations were made on the ex-HAKE prior to the exercise. The hull was drydocked at the Naval Shipyard, Norfolk, Virginia, for inspections and modifications. Internal compartments were air-tested for leaks and sealed where necessary. Valves were fitted on ballast tanks and tied into low pressure blow lines to allow topside venting control. Tests to exercise venting controls and to locate air leakages were conducted near the



Ballast and weight adjustments, valve installation on ballast tanks, and other modifications were made on the ex-HAKE prior to the salvage exercise.

ex-HAKE IN DRYDOCK AT
NORFOLK, VIRGINIA, NAVAL SHIPYARD

shipyard at a depth of 30 feet. Blow hoses were led from each of the submarine's nine topside vent valves to a control manifold. Thus, any pair of main and fuel ballast tanks could be selectively vented or blown and positive control maintained. Both the trim and the transition from positive to negative buoyancy could be finely controlled. Three different submerged tests were conducted. Minor leaks were detected and repaired. The submarine hull was also inclined after ballasting and the addition of concrete; it was found to have adequate transverse stability.

Participating Forces

The participating forces were organized in three principal elements:

Bow Salvage Element	USS HOIST (ARS-40)
Stern Salvage Element	USS PRESERVER (ARS-8)
Support Salvage Element	USS KIOWA (ATS-72)

HOIST was to tow ex-HAKE to the salvage site and position it on the bottom with PRESERVER assisting as required. KIOWA, from Harbor Clearance Unit Two (HCU TWO), would provide salvage assets, assistance and support within capabilities for the bottoming and salvage. An important initial task for KIOWA would be to tow two barges (YC's), loaded with salvage pontoons, to the salvage site. A third YC, loaded with air compressors and associated equipment, would be towed to the site by a medium harbor tug (YTM). A salvage craft tender (YRST) from HCU TWO would provide general support at the site.

USS PETREL (ASR-14) was to participate on 6–7 May for the submarine rescue operations. COMSUBDIV FORTY-ONE would be Officer Conducting the Exercise (OCE) for this phase.

COMSERVLANT was designated as Officer Scheduling the Exercise (OSE) and COMSERVRON EIGHT (ashore) was to be OCE for the positioning and salvage of ex-HAKE. Principal officers afloat were designated as follows:

On-Scene Commander	CAPT B. PETERS, USN
Salvage Master	LCDR A. F. PYATT, USN

CONDUCT OF EXERCISE – FIRST LIFT

Positioning ex-HAKE

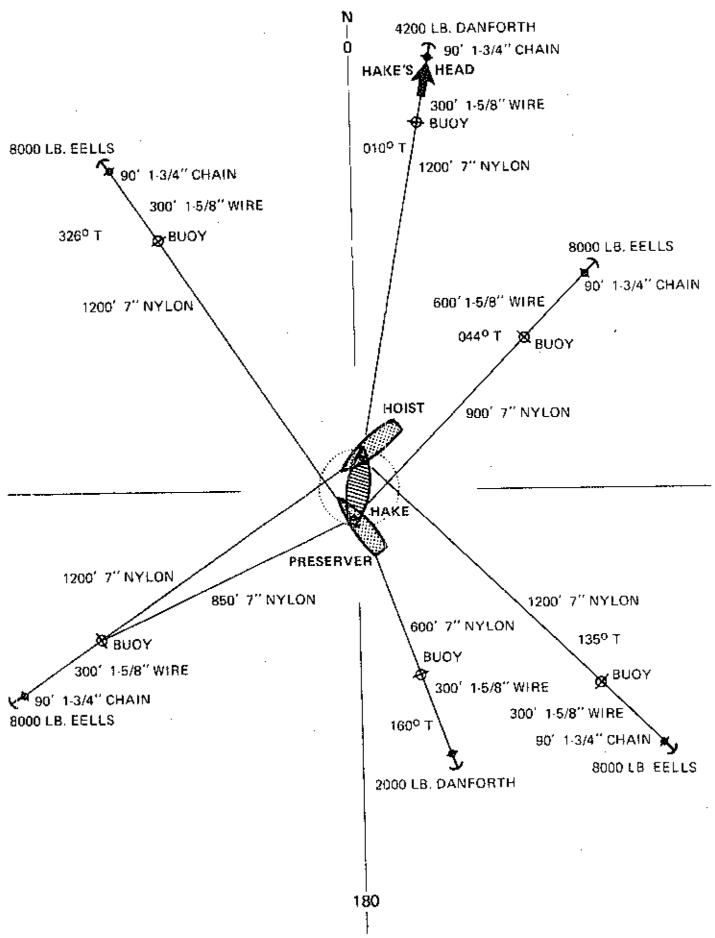
On 5 May, HOIST, with ex-HAKE in tow, departed the Naval Shipyard, Norfolk, Virginia, for the exercise site. Upon arrival that same day, HOIST positioned ex-HAKE over the point designated for sinking. Main and fuel ballast tanks were then flooded with sea water and the hull sank to the bottom in 108 feet of water. No problems or complications arose during this operation.

Submarine Rescue Phase

The rescue phase commenced on 6 May with PETREL laying a four-point moor above ex-HAKE in preparation for the McCann rescue chamber runs. It should be noted here that submarine rescue chambers are assigned to submarine rescue vessels as part of their equipment. The rescue runs, carried out throughout the day, were made fore and aft the submerged hull. Inspection of the ex-HAKE during this activity revealed a minor leak in the hull (leakage amounting to about four gallons a day) which was regarded as insignificant in nature and of no immediate concern to the planned salvage operation. Rescue runs were completed successfully and without incident, and on 7 May PETREL recovered her moor and departed the scene.

Mooring HOIST and PRESERVER

On 7 May, HOIST and PRESERVER entered into a three-point working moor above the ex-HAKE in preparation for the first lift attempt. In this regard, Eells and Danforth anchors were used to provide relative stability, i.e., working moors allowed a certain amount of freedom of movement and maneuverability for both ships, each being able to tighten or slacken mooring legs when and if required for this purpose. Arrangement of anchors and ship positions above the ex-HAKE are shown in the diagram below.



HOIST and PRESERVER were moored above the ex-HAKE in a manner which allowed relative freedom of movement.

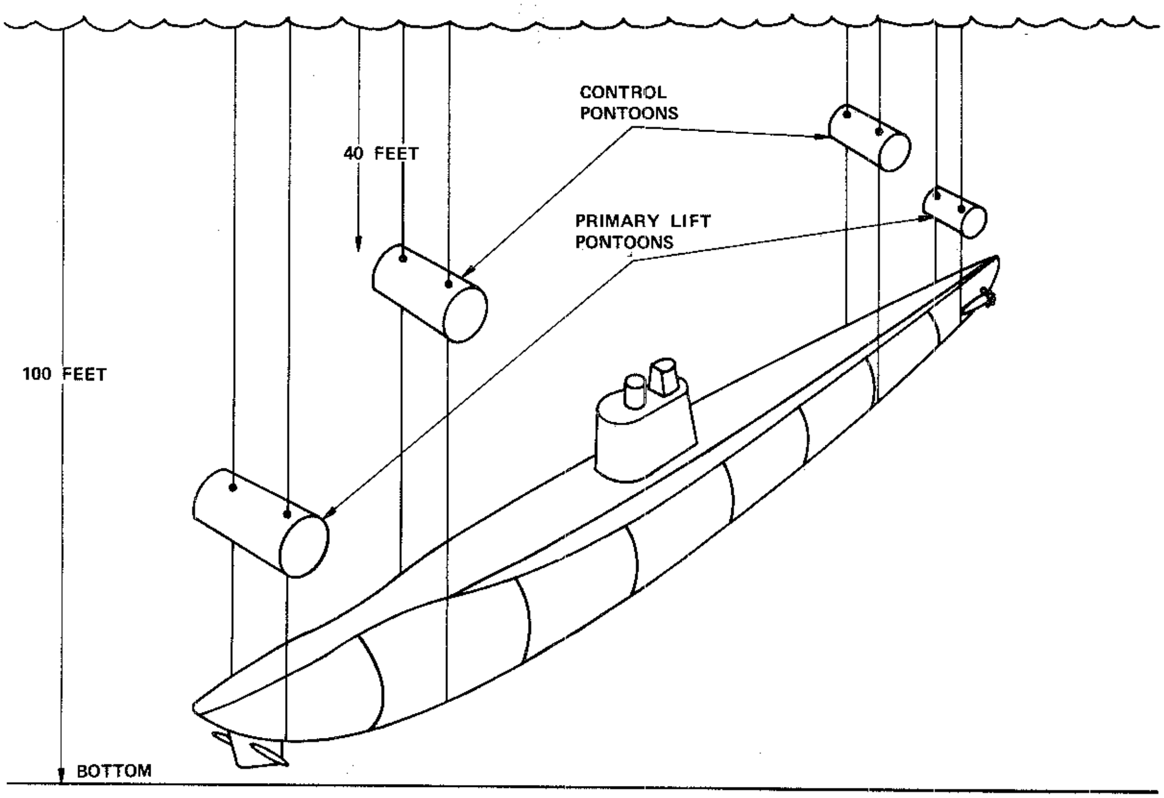
WORKING MOOR FOR THE FIRST LIFT, HOIST AND PRESERVER MOORED OVER ex-HAKE

Related Preparations

All remaining elements of the salvage task force were assembled at the site ready for the undertaking. These included the YRST from HCU TWO; the KIOWA, which arrived with two barges (YC's) in tow loaded with the submarine salvage pontoons (YSP's); a supporting harbor tug (YTM); and another YC loaded with air compressors and allied equipment. Before actual operations began, divers made a survey of the ex-HAKE which showed that the submarine was firmly entrenched in two feet of mud, except for the bow and stern which were relatively clear of the bottom.

Rigging and Positioning Pontoons

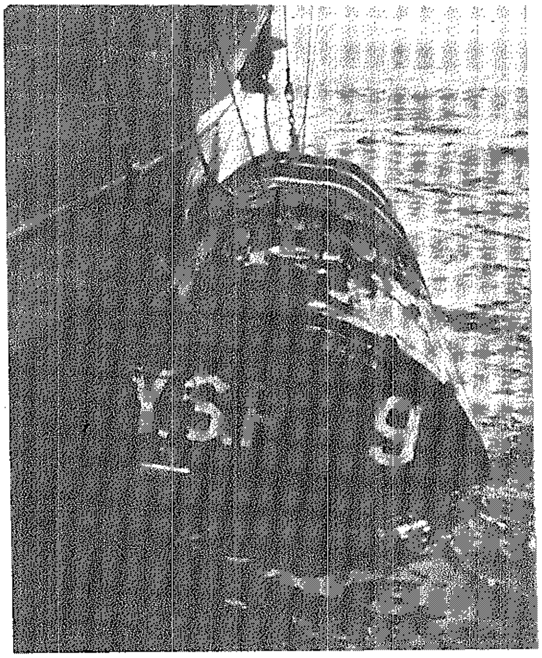
Rigging and positioning pontoons began on 8 May. PRESERVER passed a two-inch manila messenger and a one-inch wire between the ex-HAKE's propeller shafts and the hull to allow attachment of lift slings at the stern, while at the same time HOIST passed a



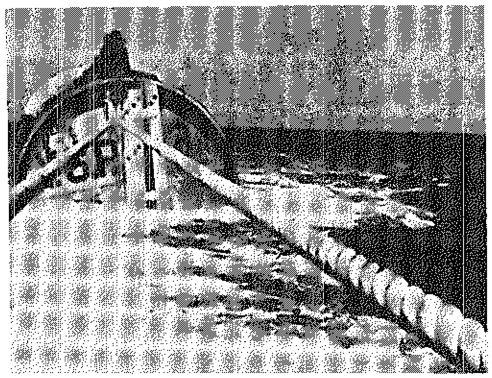
Pontoons were rigged in pairs at bow and stern of the hull for greater control during lift operations.

ex-HAKE PONTOON ARRANGEMENT

messenger wire under the bow aft the bow planes for the same purpose. Two YSP's were then launched, inspected, and prepared for positioning. Deteriorating weather set in at this point which caused a postponement of activity until 10 May, at which time two lift slings were passed under the submarine's stern. HOIST attempts to pass slings under the bow failed when these became fouled on the diving planes.



YSP alongside ARS



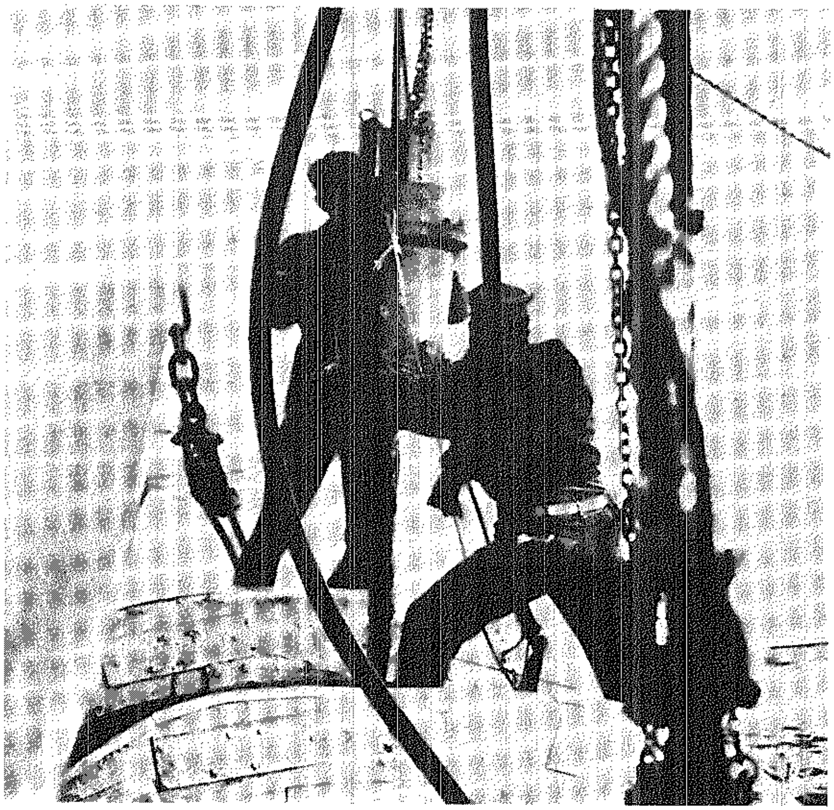
YSP Under Tow

Salvors attached one pair of YSP's at the bow of the sunken submarine hull and another pair at the stern.

SUBMARINE SALVAGE PONTOONS (YSP's)

On 11 May, the first YSP was set athwartship on ex-HAKE's aft main deck, blown to positive buoyancy, and positioned, with lift slings and blow hoses being buoyed off. Rigging and positioning of stern control pontoon at the 40-foot depth followed, with slings and blow hoses also being buoyed off.

HOIST continued to have difficulties in passing reeving wires and slings at the bow because of fouling in the bow planes. Not until 14 May did HOIST succeed in passing both slings under the bow. By 16 May, pontoons at this location were finally set and positioned, but again, not until after some difficulty in setting the control pontoon. In this case, the problem centered on the wire stoppers (flower pots) which were difficult to pass because the short one-inch wire rope tail taper was spliced to the 2-1/4-inch lifting wires.



Short 1-inch wire rope tail tapers spliced to 2-1/4-inch lifting wires made it difficult to position control pontoons.

POSITIONING FLOWER POT

Initial Lift Attempt Fails

With all pontoons in place, blow hoses were connected to the air barge anchored 100 yards abeam to starboard of the ex-HAKE. PRESERVER was stationed 85 yards ahead of ex-HAKE's position ready to tow her to shallower waters after lift was effected. Air pressure unloaders were set at 250 psi to avoid overpressurization during second lift phase. Alternate blowing then commenced on the bow pontoons. After steady blowing for several hours without any visible results, activity ceased and an inspection followed to ascertain the cause of the failure. It was found that both pontoons were sharply tilted and that the hoses were either fouled or pinched, both imperfections contributing to the absence of any noticeable signs of positive response. These faulty conditions were promptly corrected and blowing resumed on the bow pontoons. Both of these were successfully blown dry without further difficulties or complications.

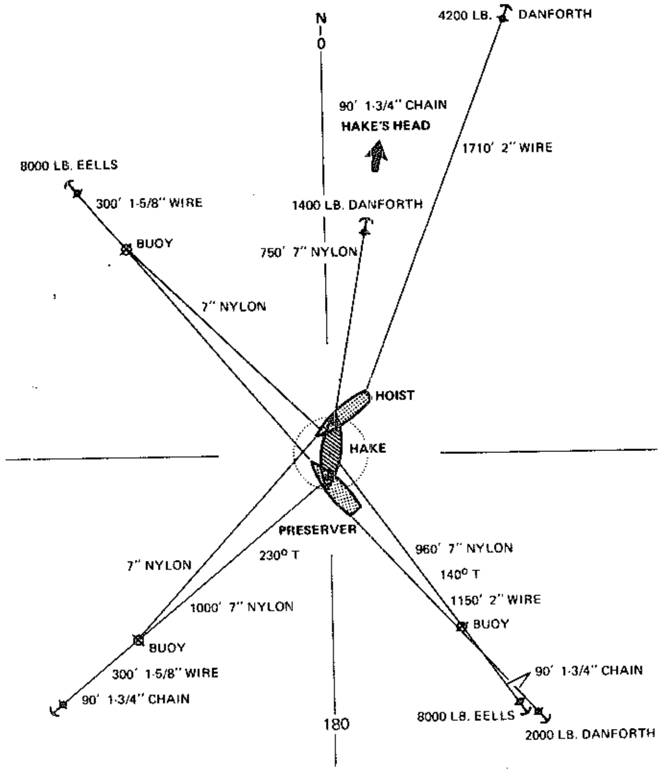
Subsequent Lift Attempt Succeeds

Operations then shifted to the stern YSP's which followed the same pattern as that applied to the forward pontoons. In due course, both control pontoons surfaced, their combined forces generating an upward pull of sufficient concentration and strength to raise and support the ex-HAKE above the ocean bottom. Appearance of the control YSP's on the surface signaled PRESERVER to begin pulling the hull toward the second sinking site nearby. This was accomplished without incident or difficulty and the ex-HAKE was then resunk in 74 feet of water in preparation for the second lift attempt.

CONDUCT OF EXERCISE – SECOND LIFT

Preparations at New Salvage Site

PRESERVER positioned ex-HAKE's anchor and then entered into a working moor in preparation for the second lift attempt. Diver inspection of the submerged submarine was



Second lift attempt required a slightly different mooring configuration since ex-HAKE was submerged in shallower waters.

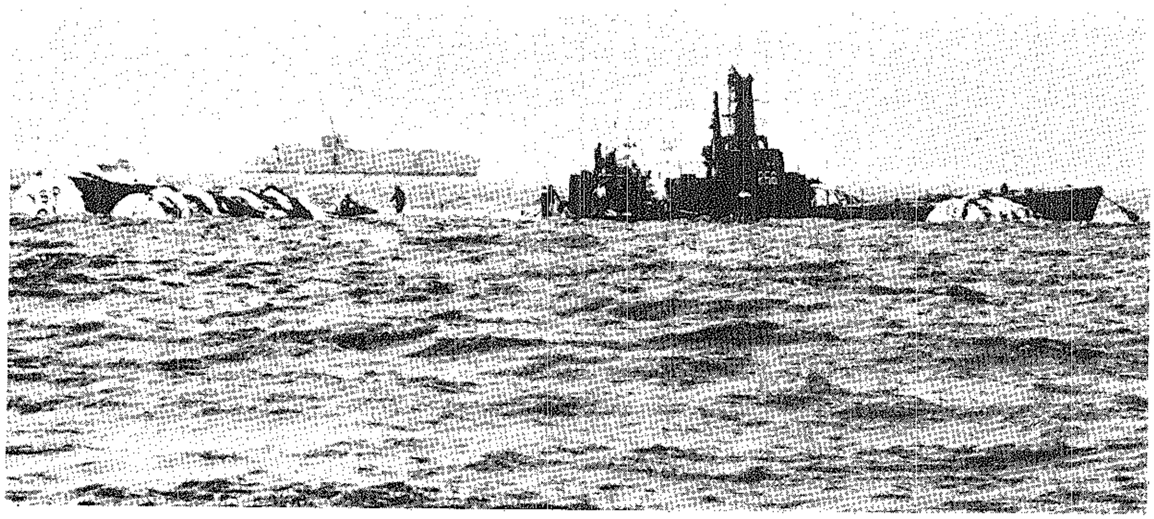
HOIST AND PRESERVER IN THE SECOND LIFT WORKING MOOR

made which showed that it was on the bottom on an even keel in approximately 74 feet of water and embedded in two feet of mud. After recovering and inspecting pontoons, blow hoses, and lift slings, PRESERVER and HOIST again positioned themselves above the ex-HAKE and proceeded to rerig the pontoons. Applied subsequent procedures, starting 18 May, were almost identical to those followed in the rescue phase, with the exception that selective blowing of ex-HAKE's main ballast tanks (MBT's) was added to the current phase to provide the extra buoyancy needed to surface the submarine. In this connection, ex-HAKE's MBT #7 was blown dry prior to the lift attempt to increase the stability.

Final Lift of ex-HAKE

On 22 May, all preparations for the final lift attempt were completed. HOIST was anchored ahead of ex-HAKE's position ready for towing after the lift. Other than minor difficulties encountered in passing wire stoppers (flower pots) to control pontoons, all systems worked smoothly to bring about a successful refloating of the ex-HAKE, this taking place on 22 May and well in advance of the planned termination date of 27–28 May.

On-site inspection of the submarine immediately following its surfacing showed that it was stable in all respects. Waterline was approximately at midpoint of the conning tower, with forward main deck dry and aft main deck at wading depth. All internal compartments were essentially dry with the exception of the forward torpedo room bilges which were immersed in about two feet of water.



ex-HAKE was successfully raised in the second lift attempt without incident or difficulty. Submarine was safely towed to Norfolk, Virginia, by HOIST.

ex-HAKE SURFACED

Return to Norfolk

Upon completion of inspection, main ballast and fuel tanks were blown dry to increase buoyancy, and bow pontoons were disconnected in preparation for tow. The two stern pontoons remained attached to ex-HAKE. On 23 May, HOIST proceeded to tow ex-HAKE to Norfolk, Virginia, where it was delivered safely at South Wall, Destroyer and Submarine Piers, U.S. Naval Station. PRESERVER, KIOWA, and other craft remained on site for recovery of mooring and rigging gear.

CONCLUSIONS

Techniques for raising sunken submarines within the limits of diving capability had not significantly changed since the raising of the SQUALUS in the late 1930's (i.e., lifting with pontoons and/or dewatering via surface supplied air), and in fact, in the area of YSP use, the Fleet's capabilities actually declined due to the loss of experienced personnel and the lack of consistent realistic training. The ex-HAKE exercise, undertaken to upgrade performance, improve submarine salvage techniques, and to confirm the value of YSP use, proved to be invaluable in this regard. Operational objectives were met and in the process vital information was gathered and important lessons were learned which added to the store of knowledge in this area.

On the basis of the outcome of this exercise experience, two specific conclusions were reached. First, use of submarine salvage pontoons (YSP's) is a valid salvage technique and should be considered and applied in future salvage operations as the circumstances dictate. Secondly, salvage of a sunken submarine is feasible if the submarine is within reach of divers.

Mud suction should be taken into account in calculating requirements for lifting. Additional excess buoyancy equal to approximately 25 percent of the total lift requirements should be allowed for this purpose. The presence of considerable excess buoyancy, particularly at the end to be lifted first, makes control pontoons essential.

A pontoon rigged athwartships on a sling is almost impossible to blow evenly since one end overtakes the other and causes the more buoyant end to flip high. By blowing the low end, which can be blown almost dry, the positions of the two ends can sometimes be reversed. However, if the sling does not render, the water in the high end will remain there and buoyancy at this point will be lost.

Pontoons can be handled more easily when flooded past mid-diameter, and when rigged in pairs parallel to the fore/aft axis of the submarine will show little tendency to render. For maximum control in handling pontoons, lift sling reeving wires should be bar tight and pontoon positions relative to the submarine should be controlled by using lowering lines.

Chain slings should be made as short as possible to reduce the likelihood of their damaging pontoon valves. Splicing 1-inch working or reeving wires to lift wires should be avoided, allowing instead a 100-foot length of 1-inch wire and cutting off the excess if this occurs. With regard to die-lok stoppers, these work well with stud link chains and are easier to handle than toggle bars with stud link chains.

In this exercise, 69-, 100-, and 150-foot lengths of blow hoses were used in setting the pontoons on positive buoyancy. After the primary and control pontoons were set for the first lift, the short blow hoses and reeving wires were buoyed off together with the expectation that effortless hookup of blow hoses to the air compressors could be effected at the surface. As it turned out, most of the short hoses became fouled with the reeving wires and had to be disconnected underwater and reset. Fouling, in this case, suggests that reeving wires and blow hoses should not be buoyed off together unless absolutely necessary.

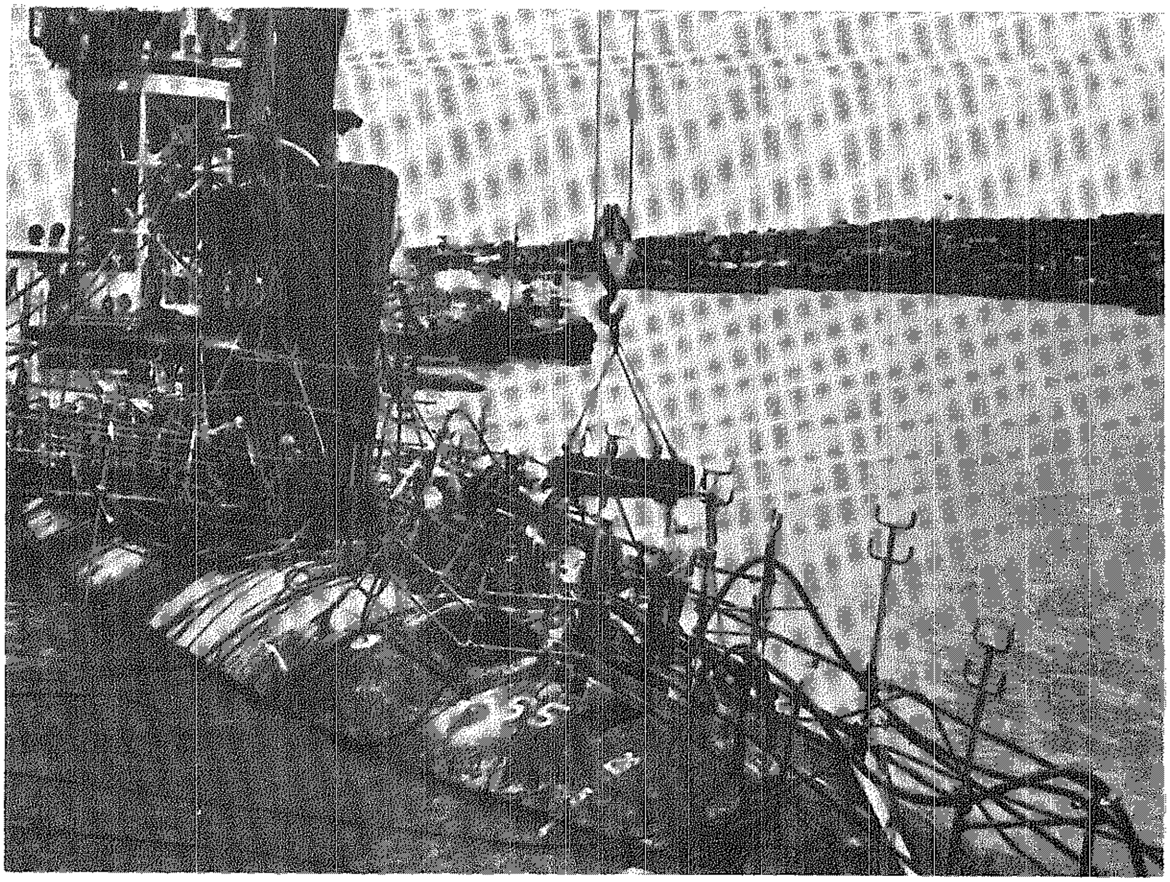
In future exercises of this type, it might be more advantageous to moor the air barge in the immediate vicinity of the submarine and salvage ship(s) for assistance in passing messenger and reeving wires and lift slings.

SALVAGE

OF

THE NUCLEAR SUBMARINE

USS GUITARRO (SSN-665)



Except for the reactor, most equipment associated with nuclear generation was on board the GUITARRO at the time of her sinking. Many temporary openings existed for installation and construction purposes.

GUITARRO AT SAN FRANCISCO BAY NAVAL SHIPYARD

SALVAGE OF THE NUCLEAR SUBMARINE USS GUITARRO (SSN-665)

INTRODUCTION

The USS GUITARRO, partially submerged and in final stages of construction at the San Francisco Bay Naval Shipyard, sank in 30 feet of water to an almost totally submerged condition as a result of unexplained sudden flooding in the bow section. Water rapidly spread from this point to other bottom areas which caused the submarine to settle quickly on the bottom at a six-degree port list.

The accident occurred on 15 May 1969. Within a three-day period that followed, the submarine was successfully raised through energetic, imaginative, and sustained application of the resources at hand. Indeed, when the GUITARRO did reach the desired surface level on the third day, its condition was such that there was sufficient buoyancy provided to allow it to enter into drydock.

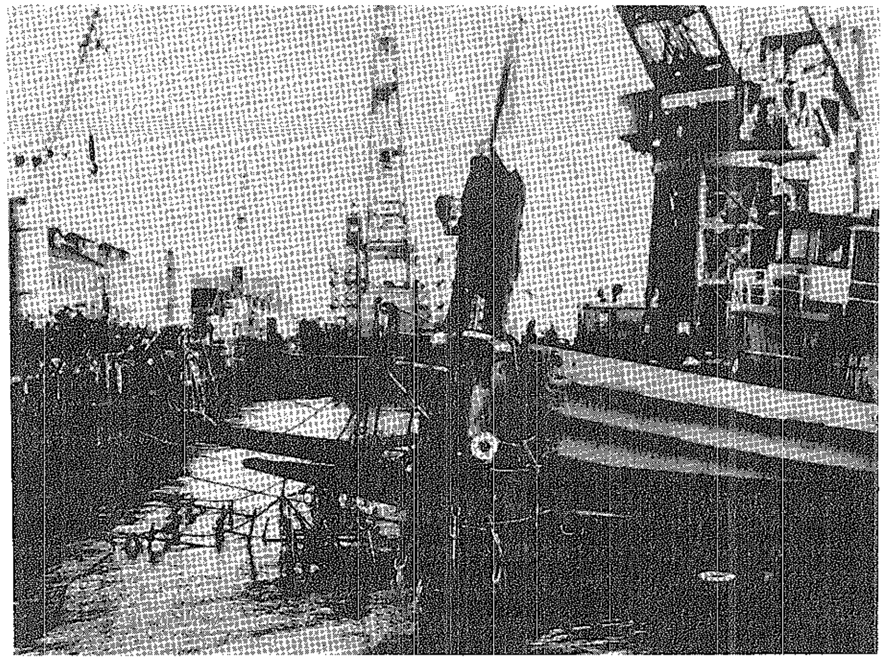
Progress in construction of the GUITARRO prior to the accident had reached a point where most of the equipment associated with nuclear power generation was either on board ready for installation or already in place (the reactor being one major exception). In this regard, several temporary openings existed in the hull at the time of the sinking which were used to admit and accommodate this equipment.

THE SALVAGE PLAN

Approach to Operations

The basic sequential approach to salvage operations was outlined by the COMSERV-PAC Salvage Officer, as follows:

Remove equipment from exposed topside of the submarine
Close all internal doors and hatches
Patch all openings
Remove water by means of combined pumping and air blowout
Utilize two cofferdams, one placed over the reactor compartment and the other over the engine room for dewatering
Use floating crane to assist in refloat



The submarine came to rest at about a six-degree list. Fairwater above the sail planes and conning tower access trunk remained above water.

USS GUITARRO AFTER SINKING AT DOCKSIDE

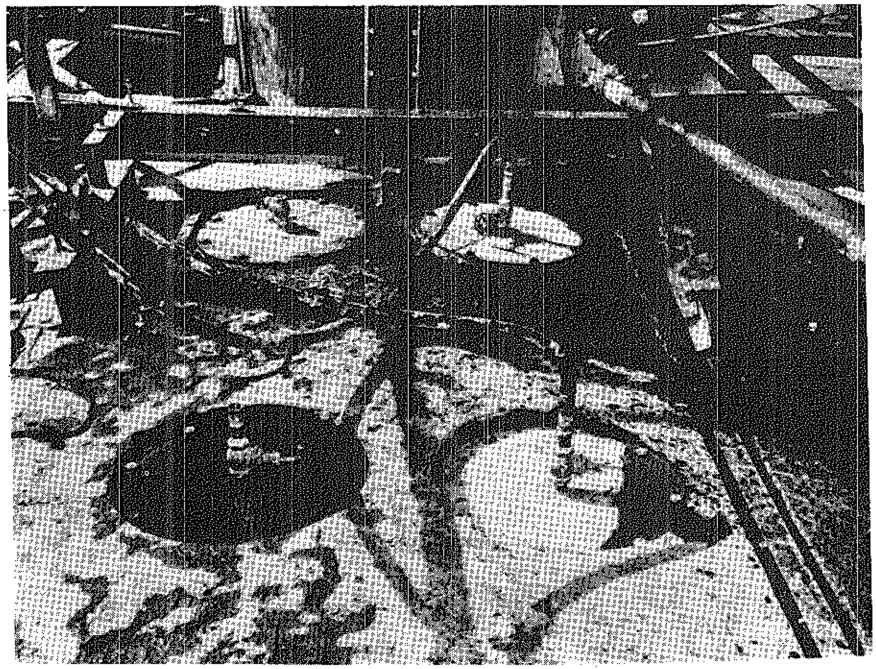
Dewatering Plan

Dewatering operations would proceed sequentially starting with the two forward compartments. The engine room would be next, followed by the auxiliary machinery room. Two aft main ballast tanks would be filled after the dewatering of the aforementioned engine room. Main ballast tanks would then be blown, after which the GUITARRO would be expected to rise to the surface. In the event that surfacing did not occur, main ballast tanks would be refilled, the reactor compartment pumped, and forward and aft main ballast tanks blown again. Since the submarine could be entered during pumping operations, the exact status of buoyancy would be known at all times.

THE SALVAGE OPERATION

Preparing for Pumping and Air Blowout

Initial efforts were directed at closing all internal watertight doors and hatches and clearing the maze of temporary service wires and vents from the topside of the submarine. Air hoses were then rigged to salvage air fittings in the two forward compartments and air pressure applied to these spaces. Both compartments were watertight. Hull openings were identified, templated, and patched. To provide additional stability to the hull, a 150-ton crane was connected at GUITARRO's aft section.



Air hoses were rigged to salvage air fittings in the two forward compartments as well as to the forward main ballast tanks.

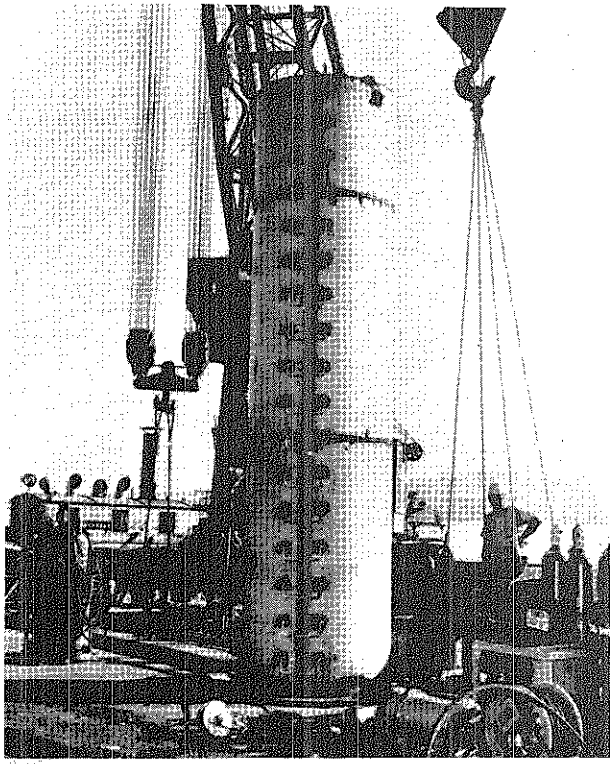
AIR BLOWOUT SYSTEM INSTALLED ON THE GUITARRO

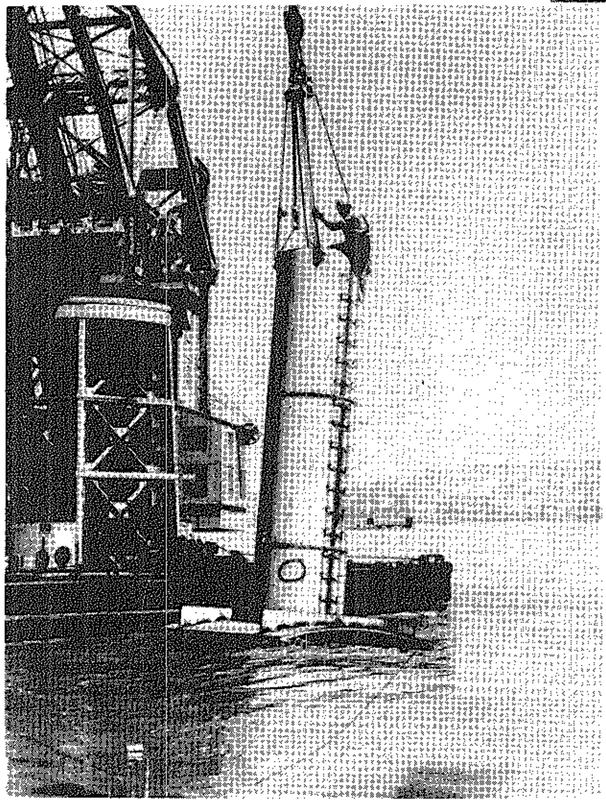
The two cofferdams (designed and constructed by shipyard personnel) were installed, one on the after access hatch and the other over the reactor compartment. Use of cofferdams would provide watertight enclosures through which water could be pumped from the submarine. Blow fittings were installed on the forward main ballast tanks in preparation for blowout there, and a fitting was placed on the sonar dome for later pumping at this point.

All of the above operations were expeditiously accomplished by dock personnel and divers without interruption and with no great difficulty.

Two cofferdams were used in dewatering operations, one placed over the reactor compartment and the other over the access hatch. Utilization of this equipment made possible the successful refloating of the GUITARRO.

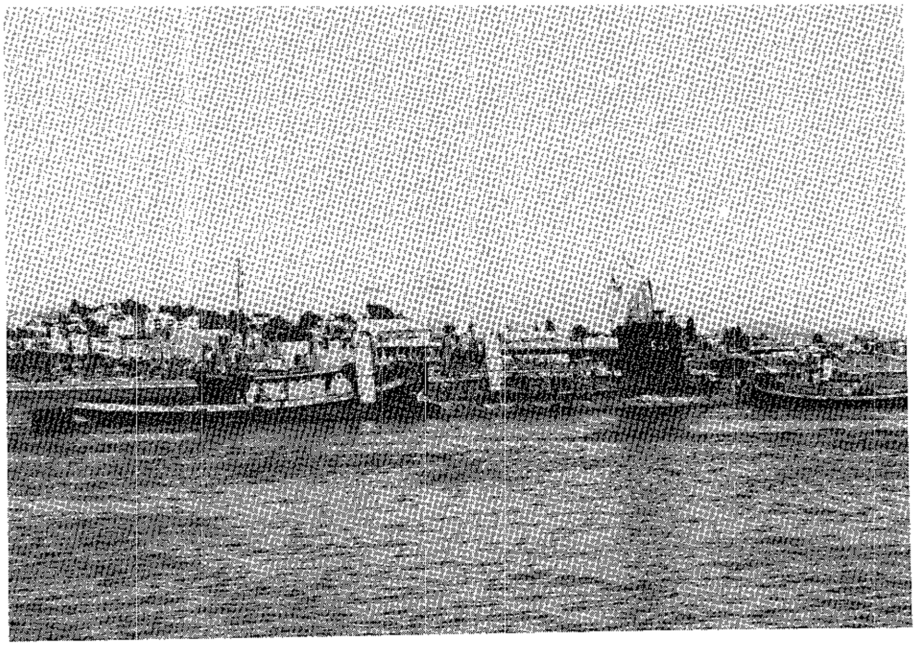
COFFERDAM BEING READIED FOR INSTALLATION ON GUITARRO





The submersible pump/cofferdam approach to dewatering proved highly effective during the operations. Employment of this method, combined with air blowout and use of a floating crane, brought about successful refloating of the submarine.

SUBMERSIBLE PUMP BEING LOWERED INTO COFFERDAM



Sufficient buoyancy was achieved following the refloating of the submarine which allowed it to enter into drydock. Salvage operations were completed within a three-day period.

GUITARRO REFLOATED AND ON THE WAY TO DRYDOCK

GUITARRO Successfully Refloated

Air blowout commenced in the two forward compartments and continued for 13 hours. Air blowout then ceased and dewatering continued using the submersible pumps. Most of the water within the hull was removed except for the auxiliary machine room which was allowed to retain water to provide ballast control during lift. Dewatering of the machinery room commenced and at the same time a 20-ton strain was taken at the stern by the floating crane. GUITARRO then rose to the surface where salvage crews completed stripping operations. The submarine was then placed in drydock for repairs and restoration.

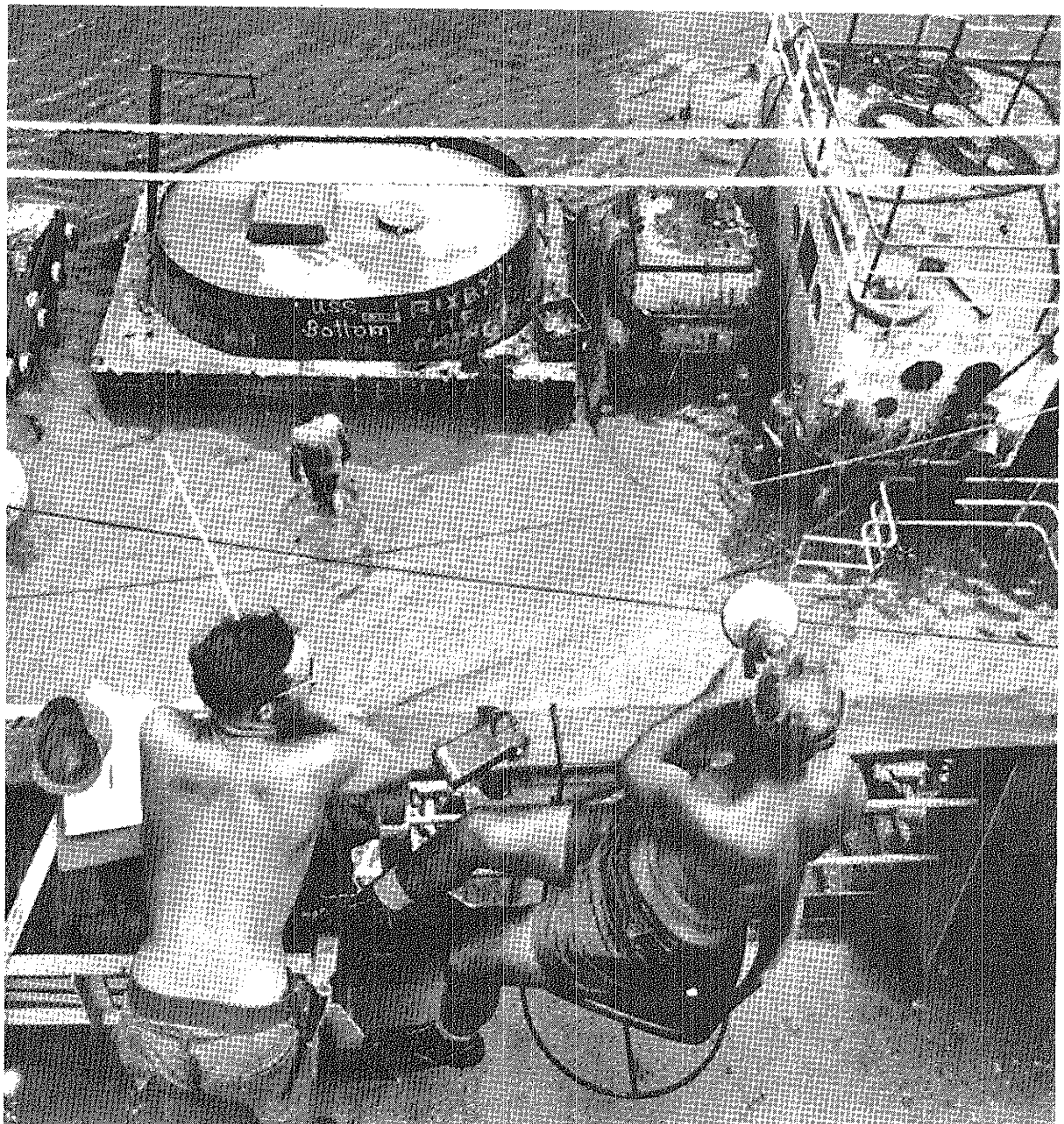
CONCLUSIONS

This operation enjoyed the particular advantage of having on hand at the time of the sinking those resources needed to meet both the demands of the circumstances and the requirements of the salvage plan. On-the-spot availability of men, equipment, and materiel served to bring about achievement of the objective in record time. This, combined with sound planning and personnel performance of the highest order, made possible the speedy recovery of the GUITARRO.

EFFORTS

TO RECOVER

THE DREDGE SANDPUMPER



Salvage efforts did not succeed in raising the SANDPUMPER, but the operation did achieve a Naval First: a grounded vessel was side-lifted by other ships.

SALVAGE CREWS INSPECT THE SUNKEN DREDGE, SANDPUMPER

EFFORTS TO RECOVER THE DREDGE SANDPUMPER

INTRODUCTION

On 22 September 1969, while on operational duty in the My Tho River, South Viet Nam, SANDPUMPER (YM 24), a dredge, sustained heavy damage when a live ordnance device was drawn into her suction pump and exploded at this point. The blast rocked the vessel and caused immediate and extensive uncontrolled flooding throughout the bottom areas. Within seven minutes of the explosion, the dredge sank to the bottom in 35 feet of water and came to rest almost totally submerged. Extreme flooding in the bow area caused this section to settle firmly in the mud. The starboard spud had cocked against the spud gates and, as a result, held the stern approximately six feet off the bottom. In the vessel's final position, submerged depth measured 35 feet at the bow and uniformly decreased to 25 feet at the stern.

THE SALVAGE PLAN

Major Considerations

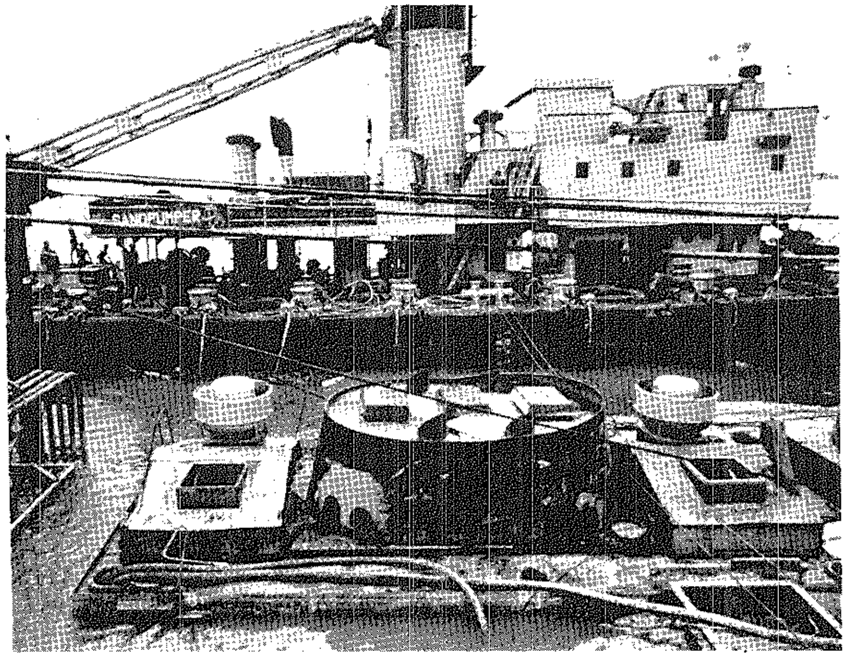
Harbor Clearance Unit One was assigned responsibility for the salvage effort. Two means of refloating were considered: 1) on-site patching and pumping, and 2) lifting the vessel by surface craft and moving it to shallower and more protected waters for patching and pumping. In view of the swift current and the ever-changing tides, which in combination would seriously hamper required diver activity in the operations and which also would most certainly lengthen the operational time, the latter course of action was chosen for the refloat attempt.

The Four-Phase Operational Plan

The salvage plan called for a four-phase operation as follows:

PHASE I	– **Prepare for arrival of two surface lift craft: CRILLEY (YHLC 1) and CRANDALL (YHLC 2)**
PHASE II	– **Transfer SANDPUMPER's lifting ladder to a barge**
PHASE III	– **Lift SANDPUMPER and move to shallower waters**
PHASE IV	– **Patch and pump until refloat is achieved**

Preparations got underway immediately following formulation of the salvage plan, and shortly thereafter all was in readiness for the undertaking.



SANDPUMPER, in foreground, was flooded throughout bottom areas and rested 80 percent submerged at high tide. Heavy lift craft is in background.

VIEW OF SANDPUMPER IN SUBMERGED CONDITION

THE SALVAGE OPERATION

Phase I – Preparing for Arrival of Heavy Lift Craft

Messenger wires were run under the SANDPUMPER and connections to her lifting ladder were severed. Moorings were placed and positioned where needed, and final preparations were made to receive the two heavy lift craft CRILLEY and CRANDALL. A suitable grounding site for PHASE III operations was selected, this being off the western tip of Thoi Son Island 1400 yards east of SANDPUMPER's present position.

During the PHASE I activities, and in a period of 24 hours, SANDPUMPER settled another 10 inches into the mud due to venting of air from side compartment pockets. Compressed air was promptly introduced into these areas, which stopped further sinking. A diver survey of the dredge showed that two-thirds of her length from the bow was firmly entrenched on the bottom.

Phase II – Removing Lifting Ladder

Removal of SANDPUMPER's heavy lifting ladder (used for transferring dredged mud, silt, and heavy objects to barges) meant that the dredge would have an additional 10-inch working freeboard once she was refloated. Elimination of this weight would also make it more likely that a successful refloat would be achieved. CRILLEY was positioned over the bow of SANDPUMPER in preparation for transferring the lifting ladder to the barge. Three attempts at removing the ladder followed, the last attempt meeting with only partial success. Brief statements describing each attempt follow.

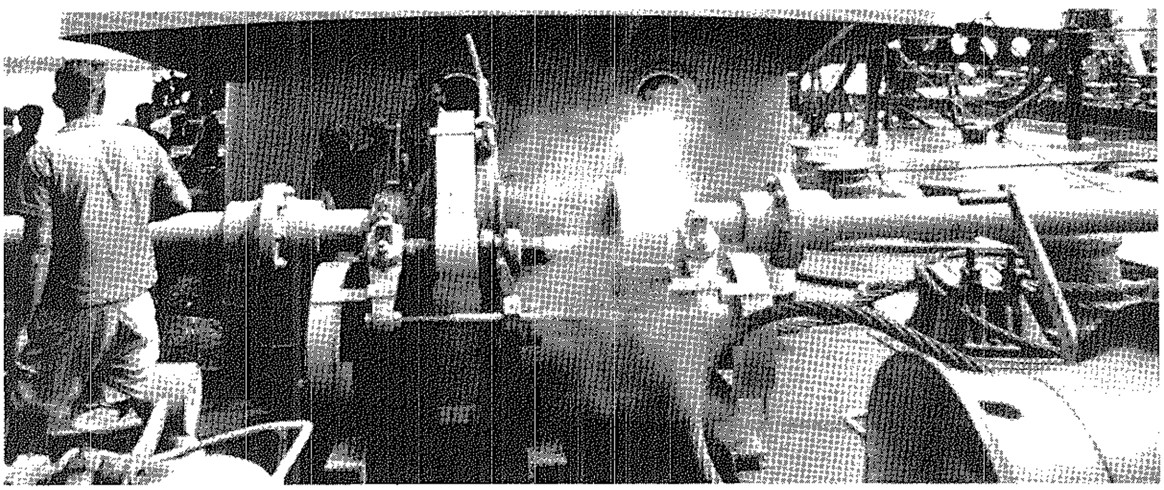
First try – no success. Lifting straps failed and shackles bent.

Second try – no success. Ladder was removed from trunnion bearings by dynamic gantry lift, but weight caused friction winches to stall out. Ladder was returned to the bearings by ballasting down.

Third try – partial success. Ladder was removed by dynamic lifting and ballasting down, but could not be raised high enough for transfer to barge. It was then dragged a few feet from the SANDPUMPER and left there for later recovery.

Phase III – Lifting SANDPUMPER to Shallow Waters

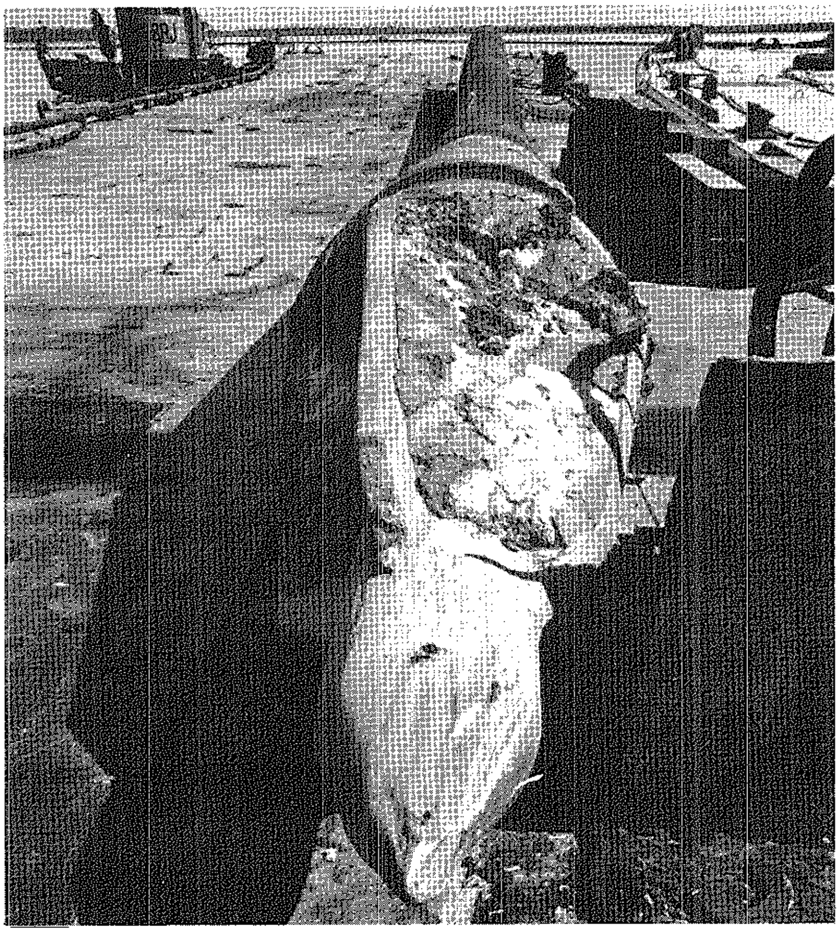
SANDPUMPER was readied for lift by CRILLEY and CRANDALL. Twenty-four lift wires were positioned under and around the dredge.



To effect lift of SANDPUMPER, 24 lift wires were passed under the dredge.

MAIN WINCH ON CRILLEY IN OPERATION DURING TIGHTENING OF LIFT WIRES

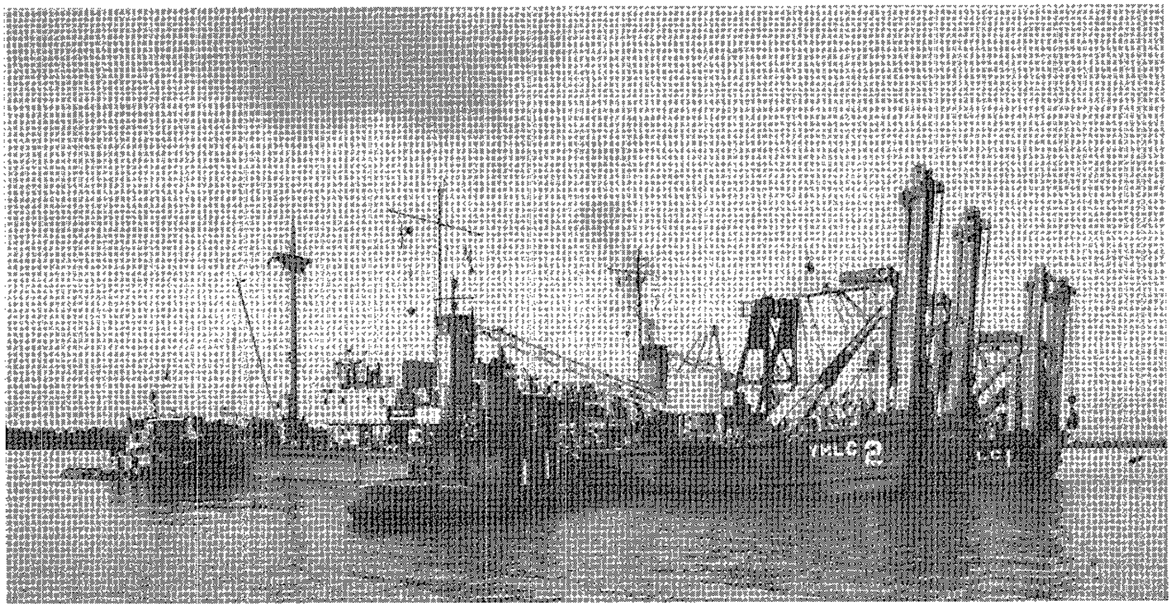
Before lifting operations could begin, it would be necessary to open SANDPUMPER's starboard and port spud gates and to remove the spuds. Attempts at pulling the gates open failed, forcing the crew to resort to blasting charges (C-4 explosives) for this purpose. Use of these explosives succeeded in opening both gates. The starboard spud was easily removed, but the port spud, mired in 30 feet of mud, would not budge. Tactics then changed to a combination of ramming and the application of a 50–60 ton vertical pull on the port spud. Finally, resistance was overcome and the spud broke off 12 feet above the bottom.



Blasting charges were used to open spud gates prior to removal of starboard and port spuds.

ONE OF TWO SPUDS FROM SANDPUMPER

Using their heavy lift capability, CRILLEY and CRANDALL commenced a series of successful side-lifting efforts which finally brought the SANDPUMPER to a resting point, with no list, 200 yards off Thoi Son Island, in 14 feet of water at low tide.



CRILLEY and CRANDALL made a series of side-lifts. Tugs maneuvered the non-self-propelled craft toward shallower water after each lift.

HEAVY LIFT CRAFT CRILLEY AND CRANDALL SIDE-LIFTING SANDPUMPER

Phase IV – Patching and Pumping

Hull and superstructure damage above the waterline was patched, as was the pumpwell hatch. Numerous cracks and holes could not be patched because these were inaccessible to divers, or because mud pressures from within the vessel made it impossible to accomplish this task. Pumping operations then began using two 6-inch and three 3-inch pumps. Four submersible pumps were also utilized, but these became inoperable in the course of the operations because of heavy mud accumulations. They were replaced by a 10-inch pump and two eductors.

As pumping operations proceeded, it became evident that dewatering in the bow section was not being achieved. Compressed air was then introduced in the bow pontoons which caused the bow to rise slightly, but at the same time forced an 11-degree list to port. To offset this condition, blowout on starboard pontoon was halted, but was continued on the portside pontoon. This tactic met with little success, and indeed, port list increased even more despite this effort.

Termination of Activities

Salvage efforts continued until 29 December 1969, with no positive results. The SANDPUMPER's condition was such that portside pumps had to be removed because of the extreme list on this side which seriously hampered dewatering activities there. Following inspection of Officer in Charge of Construction RVN Survey Board officers, it was decided to terminate the operations as of 30 December 1969.

On 1 February 1970, SANDPUMPER (YM 24) was officially stricken from the Naval Vessel Register.

CONCLUSIONS

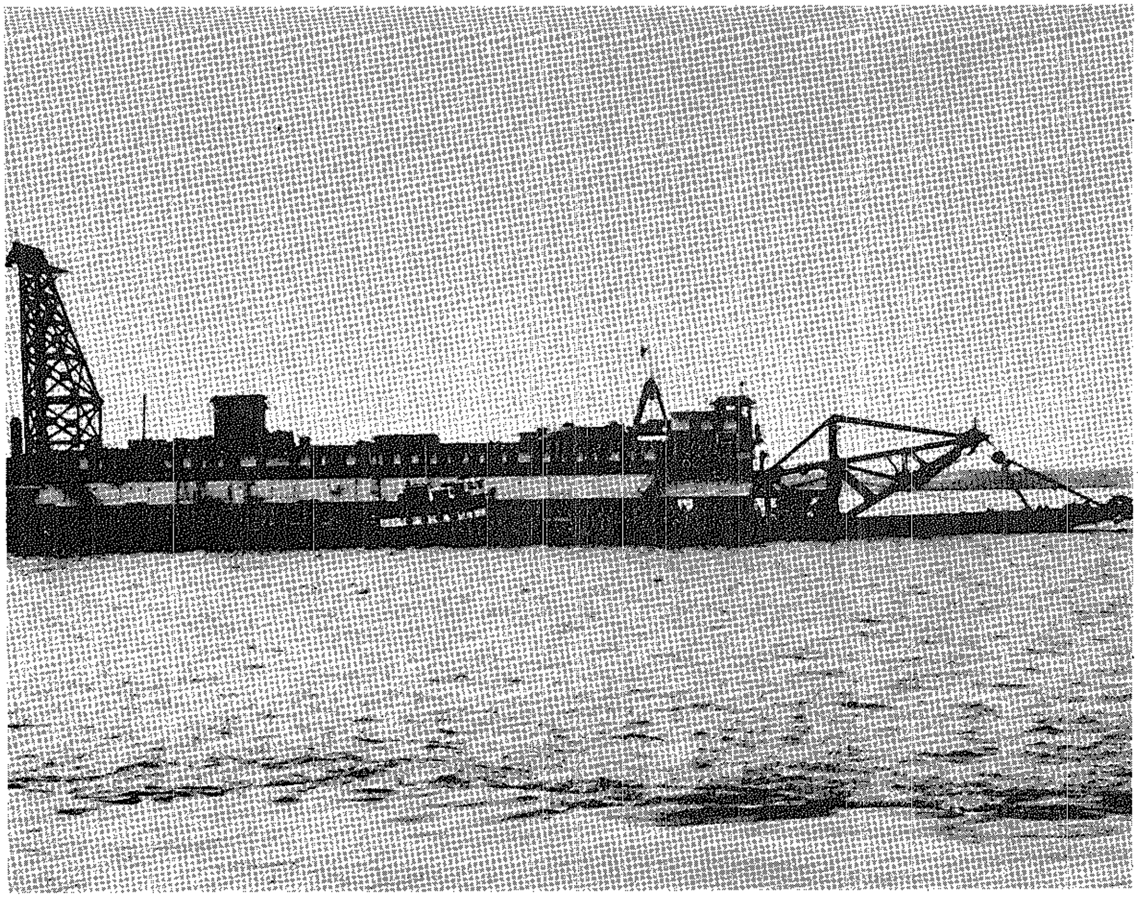
Widespread mud accumulations and flooding in inaccessible areas of the SANDPUMPER were the major factors that thwarted the efforts of those engaged in this operation and prevented the raising of the vessel. Moreover, in each dewatering attempt more mud was drawn into the hull through the many cracks and holes which could not be patched, thus adding to the existing mud accumulations.

Nevertheless, this operation achieved a Naval first: a grounded vessel was side-lifted by other ships from its entrenched position to another site. This was no small accomplishment given the operational conditions that were encountered, and is testimony of the persistence and professionalism of the salvage forces aboard CRILLEY and CRANDALL.

RECOVERY

OF

THE DREDGE NEW JERSEY



NEW JERSEY, a 30-inch pipeline dredge, was successfully refloated after a mine explosion sank her in the My Tho River, South Viet Nam.

NEW JERSEY ANCHORED IN HARBOR

RECOVERY OF THE DREDGE NEW JERSEY

INTRODUCTION

NEW JERSEY, a 30-inch pipeline dredge, struck a mine on 22 November 1969 while on dredging operations in the My Tho River, South Viet Nam. The resulting explosion caused severe damage to the inboard and forward bulkheads of the starboard spud well. Multiple holes, cracks, split seams, and wrinkles were found in this area. A large section of the spud well pontoon was completely blown off. In addition, the blast tore a large hole in the hull underneath the sternmost compartment. Tugs managed to pull the stricken vessel to shallower waters of the river (20-foot depth level) before it sank. The ship came to rest in 4 feet of mud.

An immediate underwater survey and inspection of the vessel revealed the extent of damage and flooding in the affected compartments and showed that the ship's engineering spaces were flooded to the waterline. Shortly thereafter, Harbor Clearance Unit One was assigned to the recovery effort and immediately began making preparations for the operation.

THE SALVAGE PLAN

Two courses of action were suggested and considered in this case: 1) lifting and pulling operations using heavy surface lift craft; and 2) patching and pumping to produce the necessary buoyancy needed to raise the ship. A review of the existing conditions resulted in a decision to take the patching and pumping route. The salvage plan was then outlined as follows:

Ascertain the extent of flooding and define flooding boundaries
Patch and plug damaged areas and leaks
Seal all main deck accesses and openings
Pump water and mud from flooded areas to achieve buoyancy
Remove topside weight (equipment, supplies, etc.) as required

Insofar as pumping was concerned, three 3-inch, three 6-inch, and one 10-inch pumps would be utilized intermittently or simultaneously when and where needed.

THE SALVAGE OPERATIONS

Flooding Boundaries Defined and Patching and Pumping Commence

The flooding boundary was established starting at the forward bulkhead of the aftermost compartment, and from this point running to the high water line on the machine shop bulkhead. Three small flooded compartments which sustained the heaviest damage in the explosion were at the moment bypassed in this consideration since patching in these areas was deemed almost impossible at this time. Salvage operations then proceeded as follows:

1. All hatches, ports, passageways, and other openings on deck were sealed.
2. Patching of accessible holes and leaky areas within the defined flooding boundaries followed.
3. Pumping commenced using three 6-inch pumps and one 10-inch pump installed at the starboard pumpwell.

A two- to three-foot drop in the water level was achieved on the first pumping effort. At this point, pumping was stopped to open the watertight doors between the pumpwell and adjoining spaces. Pumping resumed but operations temporarily ceased because of high tide.

Pumping commenced again at low tide. Holes found as operations continued were plugged and leaks were sealed. Lakes at the "H" beam trusses were patched with concrete. Fifteen tons of equipment, supplies, and miscellaneous gear were removed from topside.

Efforts Made to Control List

As pumping and patching continued, the NEW JERSEY suddenly broke free of the river bottom when the water differential reached the 11-foot mark and then rose slightly at a sharp 8-degree port list. It became clearly evident at this point that continued dewatering of compartments would only increase the angle of the list. The NEW JERSEY was then flooded again in order to determine the cause of the list.

On the basis of subsequent observations, it appeared that list could be adequately controlled by shutting the watertight doors on both sides of the engineering spaces and then opening them only when it became necessary to pump these areas dry. To effect this control, a blow system would be rigged on both port and starboard fuel tanks.

Three 3-inch pumps were installed in the engineering spaces and blowdown on tanks commenced. Operations continued until at high tide the NEW JERSEY broke loose from the bottom, but again at a sharper port list. As a result, two pumps broke away. The NEW JERSEY was then reflooded for another refloating attempt and the two pumps were reinstalled.

An additional 10-inch pump was installed for greater pumping power. Two more efforts were made to raise the wreck, but in each case the NEW JERSEY rose temporarily, only to settle again at a sharp port list.

NEW JERSEY Successfully Refloated

With all pumps working at full capacity (two 6-inch pumps, one on portside and the other on starboard side; two 6-inch pumps and two 10-inch pumps on the pumpwell; and three 3-inch pumps on the engineering spaces) and supported by blowdown operations on port and starboard fuel tanks, positive signs of success began to manifest themselves four hours later when the NEW JERSEY broke free of the bottom at a slight starboard list.

Seven hours later, she was afloat at a slight 2-degree starboard list. Mean draft was measured at 14-1/2 feet.

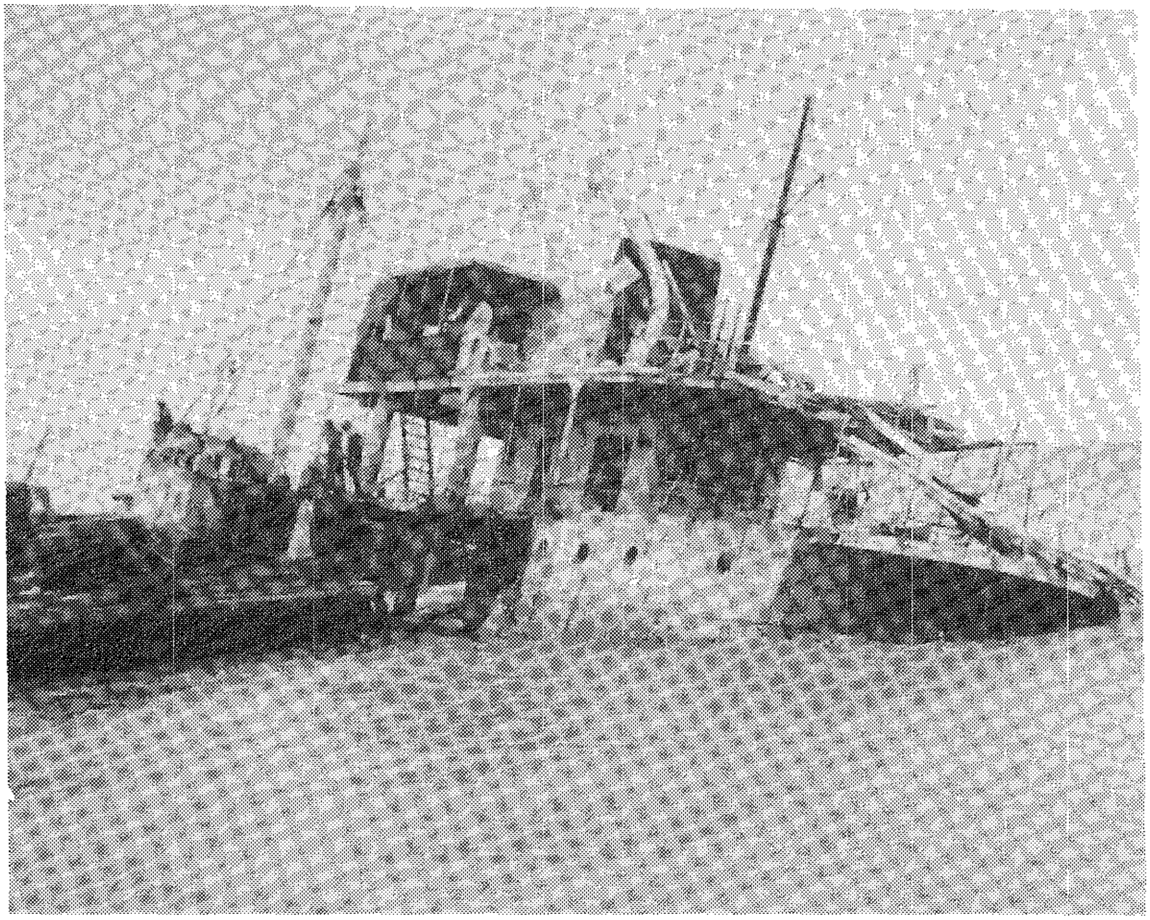
Bilges and tanks within the defined flooding boundaries were pumped dry to gain greater freeboard clearance, and damaged areas were reinforced by concrete patches.

An inspection of the dredge showed it to be in towable condition. The NEW JERSEY was then moved away from the sinking site and towed to shipyard facilities for extensive repairs.

CONCLUSIONS

The successful recovery of the NEW JERSEY – a vessel which many would have considered a total loss under these circumstances – vividly and sharply focuses on the skills, performance and perseverance of the salvage crew and on the careful planning which preceded the refloating attempts. In particular, it should be noted that, in this case, a principal factor contributing to the achievement of the objective was the decision to establish clearcut flooding boundaries prior to dewatering activity.

SALVAGE OPERATIONS IN GUYANA —
EFFORTS TO RAISE M/V POWIS



POWIS sank in relatively shallow water off the coast of Guyana after striking a sunken barge. The Supervisor of Salvage provided technical advice and assistance in the salvage operations.

POWIS SUBMERGED NEAR PORT OF GEORGETOWN, GUYANA

SALVAGE OPERATIONS IN GUYANA –
EFFORTS TO RAISE M/V POWIS

INTRODUCTION

The Supervisor of Salvage is often called upon to provide technical advice and assistance in salvage operations. Requests for help originate from many diverse sources. The circumstances that prompt the request are almost invariably difficult: a complex salvage problem in a remote area where professional salvage forces are not readily available and local resources are relatively limited.

The case of the M/V POWIS in Guyana provides an example of such a situation. A river transport vessel operated by the Guyanan government, POWIS hit a sunken barge near the port of Georgetown on 22 February. Interlocked with the barge, she settled on the bottom, defying attempts of local salvage authorities to raise her. The Supervisor of Salvage sent LT Kurt A. Gustafson, USN to Guyana as a technical advisor. This article is a summary of LT Gustafson's account of subsequent efforts to raise the POWIS.

NATURE OF THE SALVAGE PROBLEM

Situation of the POWIS

POWIS struck the overturned barge during the early morning light, sliding up onto it before coming to a full stop. The impact tore large holes in her hull on the port side forward in an area 12 feet by 25 feet, flooding the forward hold and fore peak tank. She remained afloat for two days, however, as several vessels attempted to pull her free without success. Incoming tides and swells drove her further up onto the barge. She listed sharply to starboard and finally sank.

The stern of the POWIS settled about four feet into the muddy bottom. Her port bow remained impinged on the barge, which penetrated the hull approximately three feet. Structural members of both vessels were heavily entangled. The wreck was soon flooded throughout, maintaining a list of 20 degrees to starboard. Seas were running from the east and heavy swells were being experienced, especially during incoming tides.

It was difficult to determine through underwater inspection which structural members were part of the barge and which belonged to the POWIS. Essentially it appeared that the barge's members had pushed up within the inside shell of the transport. They were acting as a hook, holding the POWIS firmly in all directions. The hooking action was not entirely adverse, however, as it would also keep the ship from jumping prematurely off the barge during lift attempts.

High tides and heavy swells added to the dangers and difficulties anticipated in carrying out the salvage plan.

BOW OF POWIS AT HIGH TIDE

Preliminary Salvage Preparations and Attempts

A wooden temporary bulkhead was constructed to cover the entire sectional area just aft of the damage in the hull. It was made watertight and checked by lowering the water in the hold aft of the bulkhead.

Two different preliminary attempts were made to recover the wreck. In the first attempt, the scheme was to pull it off the barge initially and then raise it from the mud bottom. A 3600 horsepower tug was used for this purpose but it succeeded only in breaking off the bitts on the deck of the POWIS. The strategy then shifted to one of lifting the ship clear of the sunken barge with pontoon barges. Several efforts were made to do this. Wire ropes were run underneath the POWIS and attached to the pontoon barges. However, the number of wires was insufficient and they parted on each attempt.

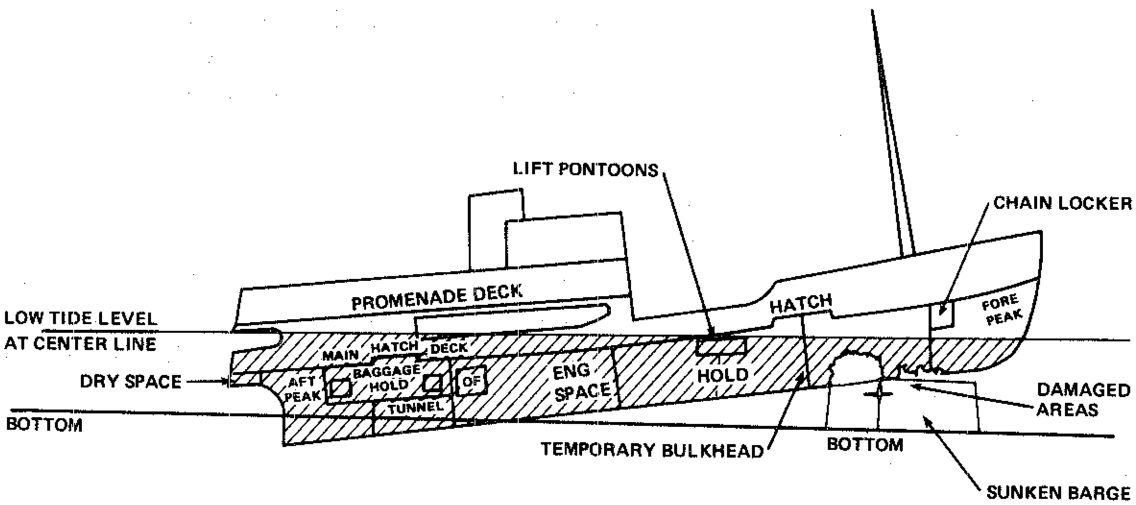
THE SALVAGE PLAN

General

LT Gustafson arrived on the scene on 23 March. After inspecting the wreck site and making an estimate of the salvage situation, he proposed a five-phase salvage plan to local authorities:

Phase I – Preparation for Salvage
Phase II – Dewatering Spaces for Lifting Vessel
Phase III – Removing Starboard List
Phase IV – Lifting POWIS off the Sunken Barge
Phase V – Towing POWIS to Drydock in Georgetown

The general plan called for making the POWIS as watertight as possible, dewatering her compartments by pumping, and controlling the lift with makeshift salvage pontoons. It was calculated that the ship, once afloat, would have a good chance of riding free from the barge. Sections still preventing the POWIS from being parted from the barge at high tide would be removed by underwater cutting.



The salvage plan called for dewatering compartments and controlling list with salvage pontoons. Penetrating members of the sunken barge would be cut to part the two vessels.

PROFILE VIEW OF POWIS SUBMERGED AT LOW TIDE

Phase I – Preparation for Salvage

Preparatory work would concentrate first on patching the damaged areas, then pumping down the forward hold and fore peak tank and cutting away members of the barge that protruded sharply into the hull of the wreck. Concurrently, the framing and shell in the areas of damage would be strengthened and the temporary wooden bulkhead would be reinforced with additional shoring.

Compartments on the main deck were to be sealed and then pumped out as the tide fell just prior to the lift attempt. All vents and air pipes on the main deck were to be sealed also and provisions were to be made for ensuring a free flow of water from the ship's tanks and between the engine room, tunnel and after hold.

Oil storage tanks, available in the local area, were to be converted to lift pontoons. Conversion required reinforcement of their sides and installation of fittings for securing chains and wire rope.

Phase II – Dewatering Spaces for Lifting Vessel

Two pumping stations were established. The forward station lines pumped out the forward hold. The after station supported pumping from the engine room, tunnel, after hold and after peak tank. It was calculated initially that four 6-inch pumps, two at each station, would be adequate. However, the seal provided by the temporary bulkhead could not be maintained and more pumps became needed. Four additional pumps were used, as well as a barge air compressor fitted with a 6-inch air pipe.

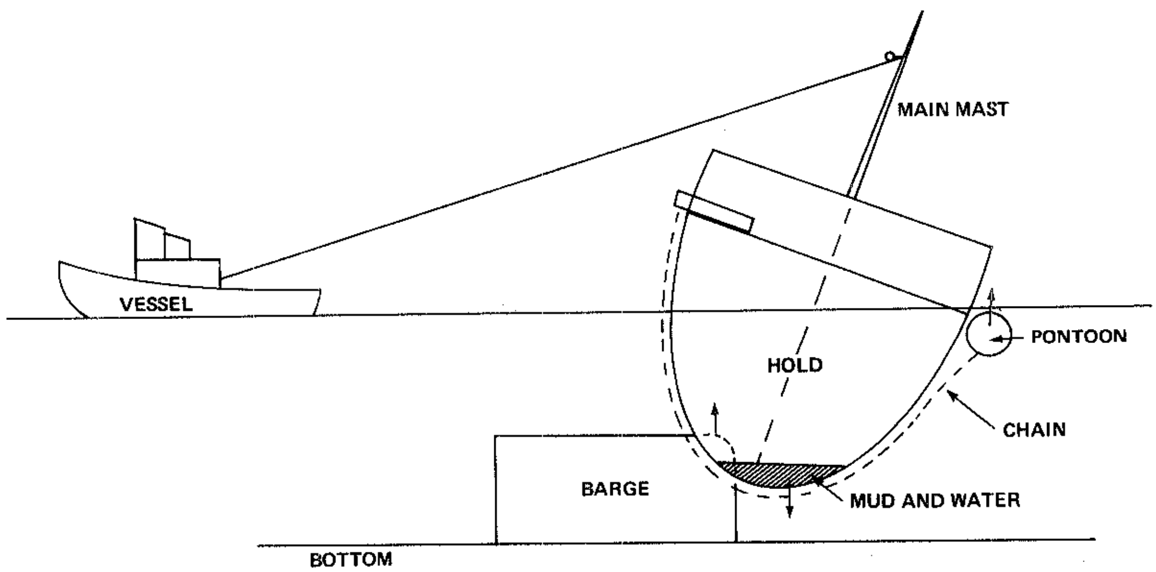
It was decided to leave the water in the fuel oil and water tanks. Dewatering these tanks was not required for buoyancy and full tanks would aid in stability after the vessel was afloat. Compartments forward on the main deck were sealed by welding plates over the hatch openings since the hatches had been washed away. Although compartments aft were not sealed, closed 10-gallon drums were inserted into these spaces to displace the water, providing additional buoyancy.

Phase III – Removing Starboard List

The vessel's maximum righting arm was at 23 degrees. Since it was already listing 20 degrees to starboard while resting on the bottom, there was little margin for additional list during the lifting operation. Plans had to be made, therefore, for providing the necessary reserve righting moment.

Other factors contributed to the problem of ensuring adequate transverse stability. The ship had been on the bottom for over a month and her compartments were heavily layered with mud. There would be a large amount of water above the main deck as well as water remaining in the after compartments when the stern came off the bottom. These factors, as well as the barge, itself, pushing upward on the port side, constituted upsetting moments.

To overcome these upsetting moments, it was planned to use two converted oil storage tanks as lift pontoons. The pontoons, each capable of lifting 40 tons, would be attached to a chain to be run underneath the wreck to the other side. A small vessel would also have a line attached to the main mast pulling toward the port side of the wreck. The center of buoyancy acting upward on the starboard side of the centerline would provide still another righting force. Ironically, lift pontoons were available in Guyana which, had their existence been known at the time, would have obviated the need to convert the oil storage tanks.



To overcome upsetting moments, two lift pontoons (converted oil tanks) were to be placed on starboard side of the POWIS. Surface vessel would attach line to mast of POWIS to reinforce control of list.

PLAN FOR PROVIDING ADEQUATE TRANSVERSE STABILITY

Phase IV – Lifting POWIS off the Sunken Barge

Once the stern was raised from the bottom so that the main deck would be out of the water, a pontoon barge would be secured to the starboard side of the POWIS. This would enhance stability and prevent it from listing and sinking again at the next low tide.

It was calculated that the POWIS would have 40 tons of buoyancy at high tide, acting upward against any impeding members of the sunken barge. Work would be undertaken to remove mud remaining in the compartments, thereby not only directly reducing the upsetting moment on the ship but also the reaction force of the barge on the wreck. It was thus hoped that the POWIS would run off the barge at high tide. This expectation increased as preparations proceeded because the size of the hole in the wreck's hull increased as time went by. It was thought that the enlarged hole would allow the POWIS to slip off more easily.

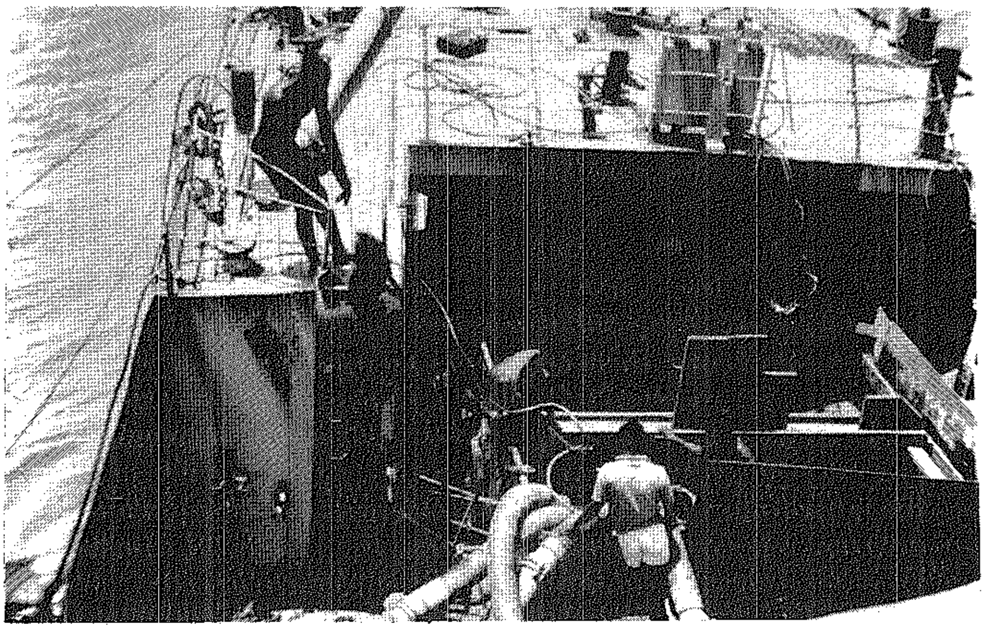
Phase V – Towing POWIS to Drydock in Georgetown

It was planned to tow the POWIS into the seas until the channel to Georgetown was reached, a distance of 11 miles as compared to a direct line trip to Georgetown of five miles. The vessel would be floating with the bow down due to the flooded spaces forward. With reduced reserve buoyancy, stability would remain critical. Accordingly, towing into the seas was planned as a measure to reduce rolling and the possibility of overturning. The alternative of proceeding directly to Georgetown with the seas off the port beam would make it more difficult to maintain stability.

ATTEMPTS TO IMPLEMENT THE SALVAGE PLAN

No significant efforts were made to patch and pump out the fore peak tank and the forward hold. Further calculations indicated that the vessel would float and possibly rise off the sunken barge even with the forward hold flooded in front of the temporary bulkhead. This probability, coupled with the inexperience of the available divers and the need to concentrate on the temporary bulkhead, led the salvors to abandon this feature of their original plan.

The temporary wooden bulkhead failed due to a combination of heavy seas and inadequate construction techniques which failed to use the full strength of its 5-inch timbers. All work effort was immediately concentrated on repairing it and shoring it as the integrity of the bulkhead was vital to the success of the salvage plan. However, its caulking and wedging continued to be washed away during the incoming tides. Various methods were used to improve the sealing. Burlap bags weighted down with anchor chains were wedged in

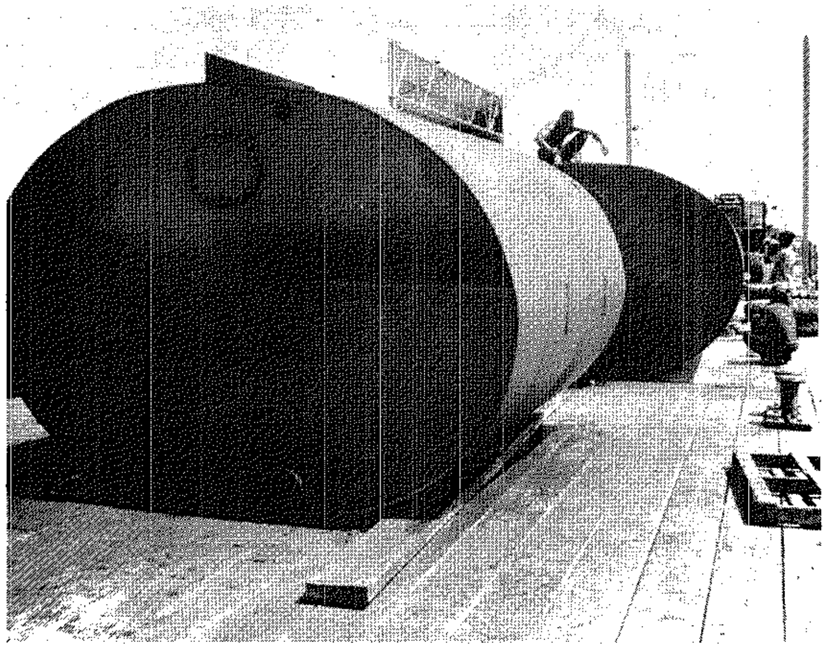


Two pumping stations were established on the POWIS, one at the forward hold and the other at the aft engine room. Pumping at forward hold was abandoned principally because calculations indicated that vessel could be refloated even though the forward hold was flooded.

FORWARD PUMPING STATION AFT OF TEMPORARY BULKHEAD

front of it. Pipes penetrating the bulkhead were cut off and their openings patched. Bags filled with sawdust were concentrated at the juncture point of the bulkhead and the skin of the vessel. Tarpaulins and oakum were also used. Even the use of plastic sheets was considered although not actually attempted.

Delays were encountered in converting the two oil storage tanks to lift pontoons. Almost three weeks were required to fabricate them. Further frustrations were experienced when they were finally brought to the wreck site. One sank and the other drifted away. Consequently, the plan had to be altered to use a large pontoon barge in their place. The barge was to be rigged with two logs between it and the starboard side of the POWIS to make a rigid connection. Then chains were to be run underneath the POWIS and connected to the logs.



Two oil tanks, each having a 40-ton lift capacity, were converted to lift pontoons for the operation. Salvage plan was altered when these two pontoons were lost after arriving at the salvage site.

LIFT PONTOONS BEING FABRICATED FOR LIFT ATTEMPTS

The services of an underwater cutter from Trinidad were obtained with the intention of employing him to cut away any sections still preventing the POWIS from being parted from the barge at high tide. However, the danger of the POWIS jumping while he was cutting made him wary of attempting this. He therefore proposed to place air locks in the sunken barge and partially float it while the POWIS was being raised. This would allow both the barge and the POWIS to be lively. This scheme was attempted several times but the welding plants that were made available were not suitable or were too inefficient to be usable for the task at hand.

The salvage force proceeded to patch the fore peak tank and to test the patching by pumping the space down. However, the pounding of the POWIS on the barge created new holes in this tank. Provisions were made to use compressed air to force the water from this tank. Other preparatory work was accomplished to remove davits, winches, anchor chains and other heavy equipment from the main deck of the transport.

Several attempts were made in mid-April to pump out the wreck preparatory to lifting. In one effort, the entire vessel was nearly pumped out with the exception of the fore hold and the ship became lively. However, the salvage force was unable to coordinate this action fully with related requirements for emplacing the pontoon barge and positioning assist ships to help control the POWIS during the lift.

LT Gustafson left Guyana on 21 April. In spite of the difficulties and delays, it appeared that the necessary foundation had been made for a successful lift attempt.

CONCLUSIONS

Although the POWIS was close to shore and in relatively shallow water, the seas were still directly instrumental in preventing a successful salvage. Much of the effort in preparing the ship for the lift attempt was undone by the strong forces at work in the swells. The heavy swells broke away the barge and lift pontoon resulting in costly delays. Sea conditions also limited underwater work to a period of two and one-half hours preceding and during slack tide.

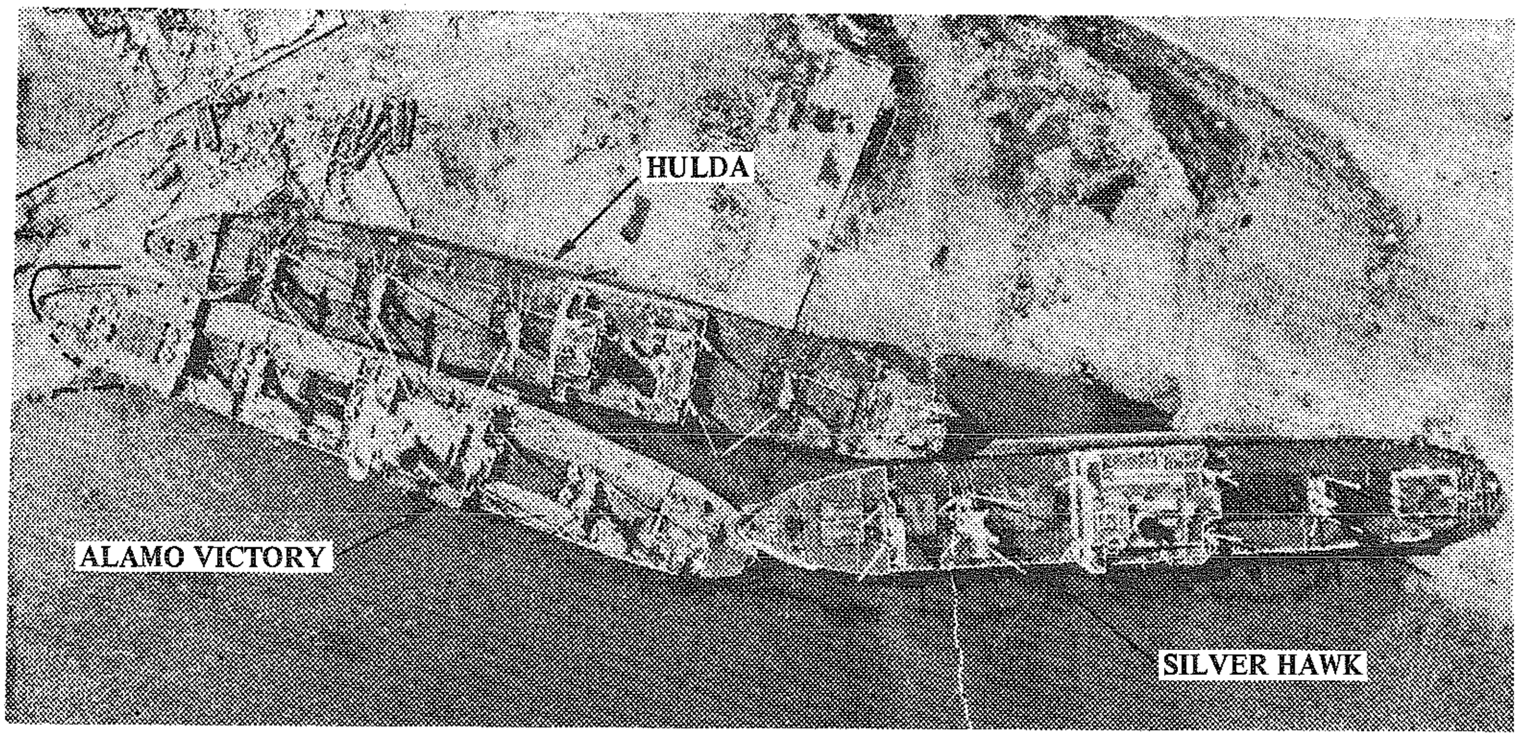
Further delays were encountered because the salvage force was essentially a provisional organization comprised of inexperienced personnel using hastily assembled equipment. It was, in short, an amateur force in a situation demanding professional expertise.

The operation also points up the need for extensive shore support in salvage operations. Marshaling the necessary resources and responding quickly to the needs of the salvage force at the wreck site are difficult and vital tasks. The operations of the supporting organization ashore must be planned and executed with the same force and thoroughness as those of the salvage force afloat.

SALVAGE

OF

GROUNDED VESSEL
SS ALAMO VICTORY



Vessels ALAMO VICTORY, SILVER HAWK, and HULDA were torn loose from their moorings by hurricane "Camille" in August of 1969 and pushed aground within the harbor at Gulfport, Mississippi.

ALAMO VICTORY WITH TWO OTHER SHIPS AGROUND IN GULFPORT, MISSISSIPPI HARBOR

SALVAGE OF GROUNDED VESSEL
SS ALAMO VICTORY

INTRODUCTION

In the wake of devastating winds and high tides generated by hurricane "Camille" along the Mississippi-Louisiana coastline in mid-August 1969, three vessels, SS ALAMO VICTORY, SILVER HAWK, and HULDA, were torn loose from their moorings in the Gulfport, Mississippi port and run hard aground within the confines of the harbor. The three ships were beached together in clustered formation (ALAMO VICTORY directly outboard of HULDA, and outboard and ahead of SILVER HAWK), on sandy bottom and among broken sections of reinforced concrete pier pilings and other debris.

The grounding of the ALAMO VICTORY became the immediate concern of the Military Sea Transportation Service (MSTS) which operated the vessel, and on 19 August MSTS representatives were on the scene for survey and inspection of the ship and the grounding conditions. Although the other two vessels were of non-MSTS interest, a distinct possibility existed at that time of a concurrent cooperative salvage effort involving all three ships. No timely decision was reached in this matter insofar as the owners and agents of the two merchant ships were concerned, so that salvage operations on the ALAMO VICTORY were carried out without the aforementioned possibility being realized.

MSTS authorized the Supervisor of Salvage to proceed with salvage operations. In due course, Murphy Pacific Marine Salvage Company was designated prime contractor for the task and charged with providing all management, on-scene direction, and logistic support, including sub-contract services, as required. The salvage vessel M/V CURB, in the service of Murphy Pacific Marine Salvage Company, was to be the principal salvage ship in the operation.

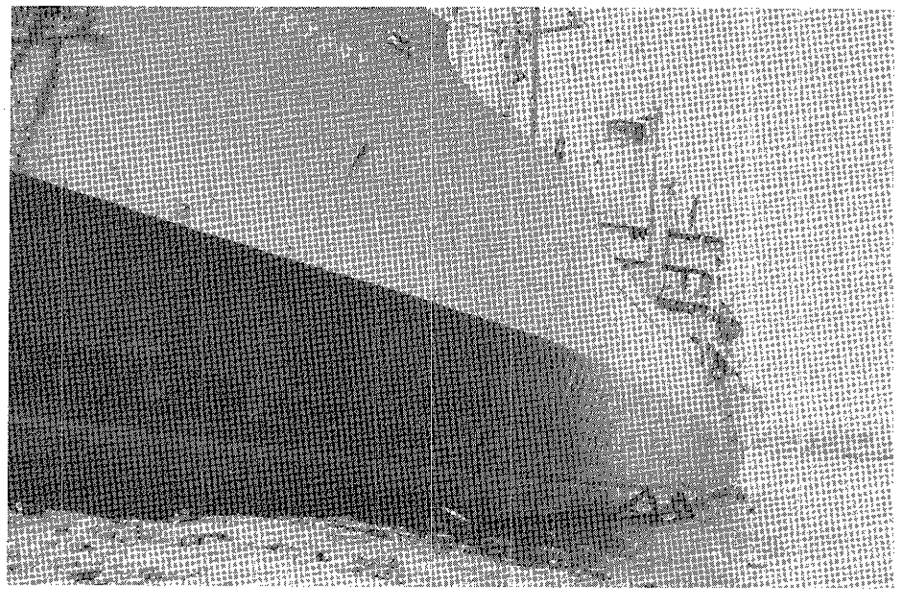
ALAMO VICTORY was successfully extracted from her entrenched position by means of beach gear, off-loading of cargo, dredging, and by removal of debris in the vicinity of the ship. In this regard, the Army Corps of Engineers lent a valuable assist throughout the salvage operations in connection with their own assigned duties of clearing underwater debris in the harbor, taking soundings, and making general surveys.

THE SALVAGE PLAN

Vessel Grounding Situation and Condition

ALAMO VICTORY rested an estimated 6,000 tons aground on a westerly heading, and at a 10-degree port list, parallel to the beach and outboard of stranded merchant vessel HULDA. Water depth readings along the starboard side from stern to bow ranged from 0'0" to 11'6", and along port side from 0'0" to 13'5". Damage to hull was negligible and no interior flooding occurred. Damage to the skeg and the rudder post was observed. All power systems were in working order. Cargo aboard at the time of grounding consisted of 1,959 long tons of lumber, Army vehicles, and several large metal drums. In addition to this weight, 800 tons of bunker fuel was stored in the ship.

Underwater debris littered the grounding site area, and in fact, ALAMO VICTORY rested atop several large broken concrete pier sections. A sunken barge was discovered about 300 feet off the stern of the ALAMO VICTORY, but was not considered a threat to the anticipated salvage operations.



ALAMO VICTORY was forced aground atop broken sections of concrete pilings and other debris. Fortunately, no major damage was sustained by the hull.

PORT SIDE VIEW OF ALAMO VICTORY AGROUND

Elements of the Salvage Plan

On the basis of the above described conditions and the inspections which followed, a salvage plan was formulated which spelled out actions to be taken as follows:

Off-load cargo
Remove mud, debris, and other obstacles around the wreck
Dredge an 18-foot channel away from the ship to deeper waters
Using the bow of the wreck as a pivot point, swing vessel at stern into channel by means of six sets of beach gear, each set to consist of:
- **two 8,000-lb. Eells anchors**
- **two 600-foot 1-5/8" wire cables**
- **one set of quadruple sheave beach falls set on ship's afterdeck, with the No. 4 and No. 5 hatch cargo winches used to heave on the cables**

Refloat and tow the vessel from the grounding site

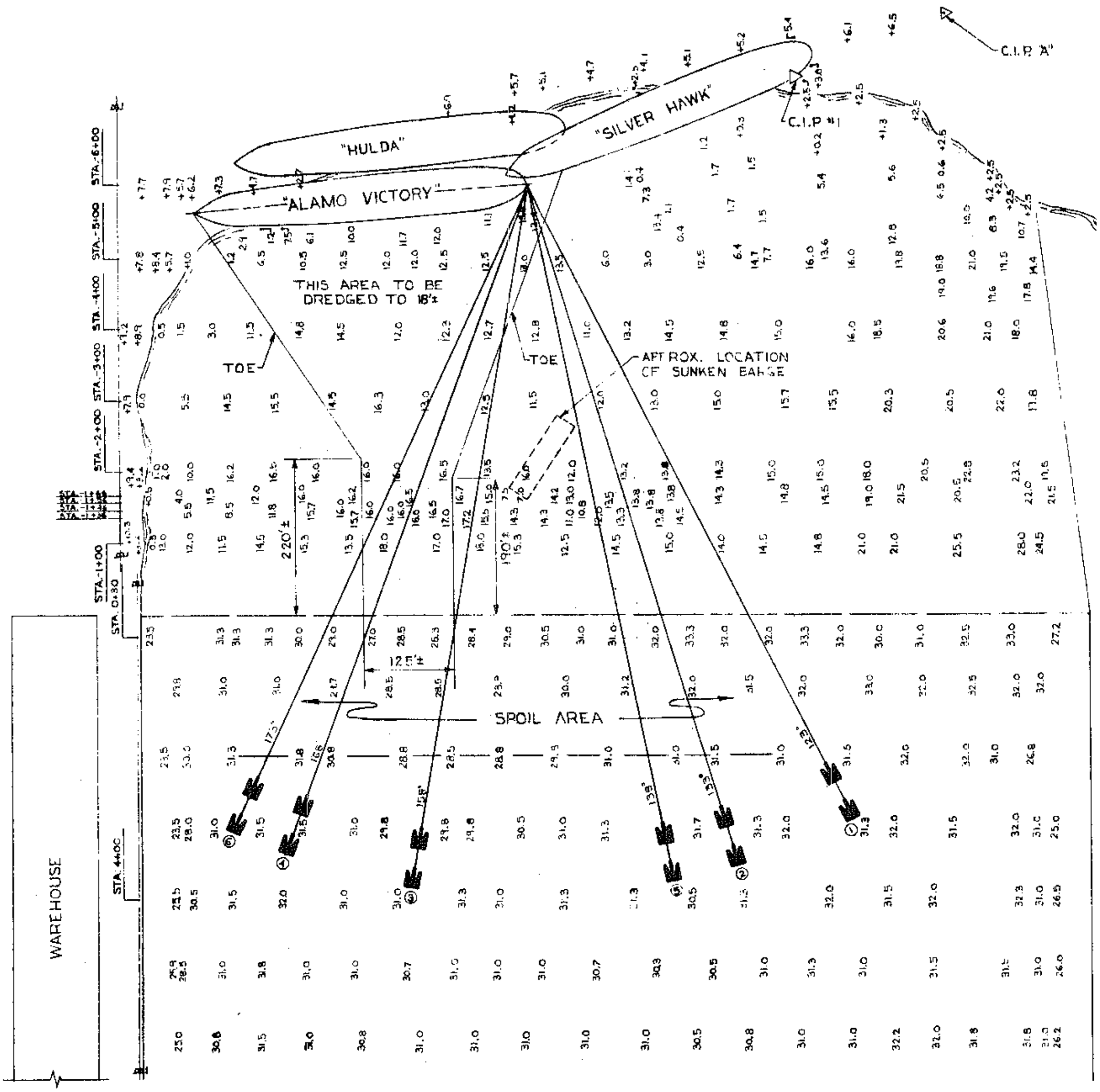
In support of the steps to be taken, underwater surveys of debris conditions, determinations of water depths, and inspections of the submerged portions of the ALAMO VICTORY would be made both in advance of and during the operational activity.

THE SALVAGE OPERATION

Initial Activity

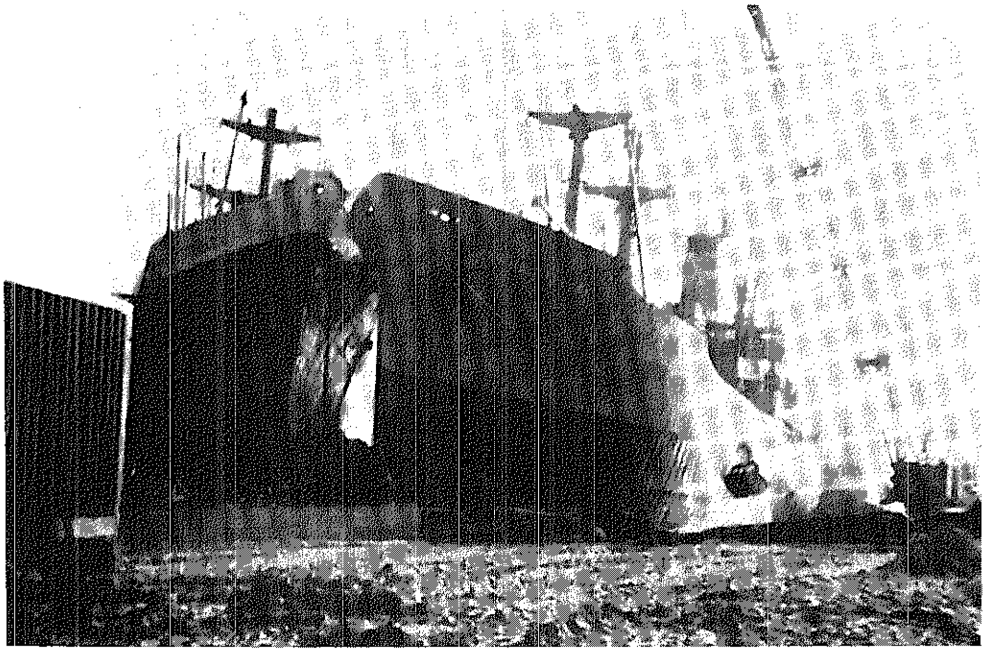
Cargo discharge commenced on 25 August. Meanwhile, the area to be dredged was marked off by buoys and range markers in preparation for the arrival of a 16-inch dredge acquired from Bender Ship Repair, Pascagoula, Mississippi, and scheduled to reach the site on 29 August. Concurrently, surveys were made to determine the extent and concentration of underwater obstacles; soundings in the vicinity of the ship were taken; and on-site diver inspections were conducted – all such activities aimed at providing an accurate picture of the physical and environmental conditions as they existed.

M/V CURB arrived at the scene on 27 August and her crew immediately began rigging beach gear on the wreck. On 29 August full-scale dredging commenced, with dragline shovel obtained from the Army Corps of Engineers being used to clear debris within the dredging boundaries. By 8 September unloading of cargo and fuel was accomplished and, as dredging continued, arrangements were made to secure tugboat COMMODORE to scour the port side astern, and in addition, to use a jet pump to force mud and debris away from under the vessel. Two sets of beach gear were laid on this day followed by a third set on the next day.



Six sets of beach gear rigged to the stern of the ALAMO VICTORY were to be used in the refloat attempt. Bow would serve as pivot point in swinging the vessel out from the beach.

PLANNED BEACH GEAR ARRANGEMENT



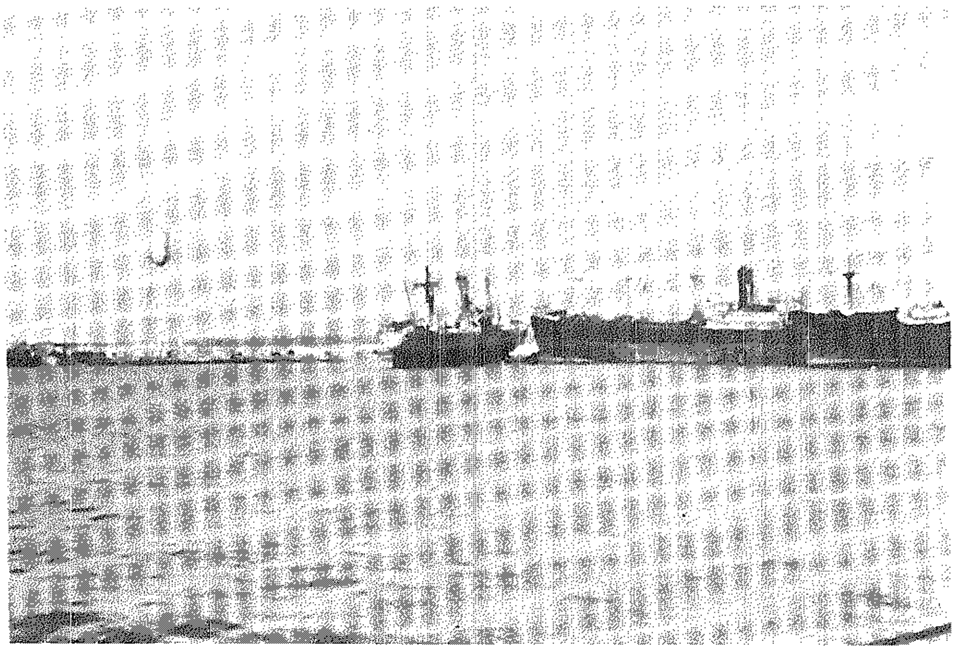
Mud, dirt, and debris removal was accomplished by use of clamshell bucket at the bow area and by scouring and jet pumping off the port stern section.

DREDGING OPERATIONS AROUND BOW OF ALAMO VICTORY

On 10 September dredging had progressed to the extent which allowed two more sets of beach gear to be laid. Divers discovered that the port bilge keel was ripped and a large section was hanging from the wreck. Hanging section was cut off by the divers. Tugboat COMMODORE arrived at the scene and commenced scouring under the stern of the wreck. By 16 September all six sets of beach gear were in place and ready for tightening, and on 17 September, as scouring, dredging and digging out by clamshell bucket continued, a full strain was taken on all sets. All booms on the ALAMO VICTORY were lowered to their stowed positions to prevent possible swinging when the vessel was moved.

Refloat Achieved

The next day, ALAMO VICTORY responded to the pull of beach gear by moving two feet astern at high tide. Beach gear legs were then slackened selectively to allow the wreck to work back and forth and to loosen debris under it. Stern movement increased as operations continued. As a precaution, three emergency portable pumps were placed aboard the wreck in case flooding should occur on refloat. On 20 September, ALAMO VICTORY became increasingly lively as the incoming tide neared its high point. Ground reaction was estimated at 288 tons. At this point, 200 tons of ballast was added to the aft port fuel tank which effected a rise of 11 inches to the bow section and a simultaneous lowering of 20 inches to the stern. With a full strain being taken on the stern by all beach gear, ALAMO VICTORY pivoted at the bow and moved slowly off the beach, free, clear, and afloat. Tugboat COMMODORE then proceeded to tow her to berth in the harbor.



Refloat was achieved by means of six sets of beach gear rigged on the stern of the stricken ship. Bow was used as a pivot point in swinging stern out from the beach.

POSITION OF ALAMO VICTORY PRIOR TO REFLOAT

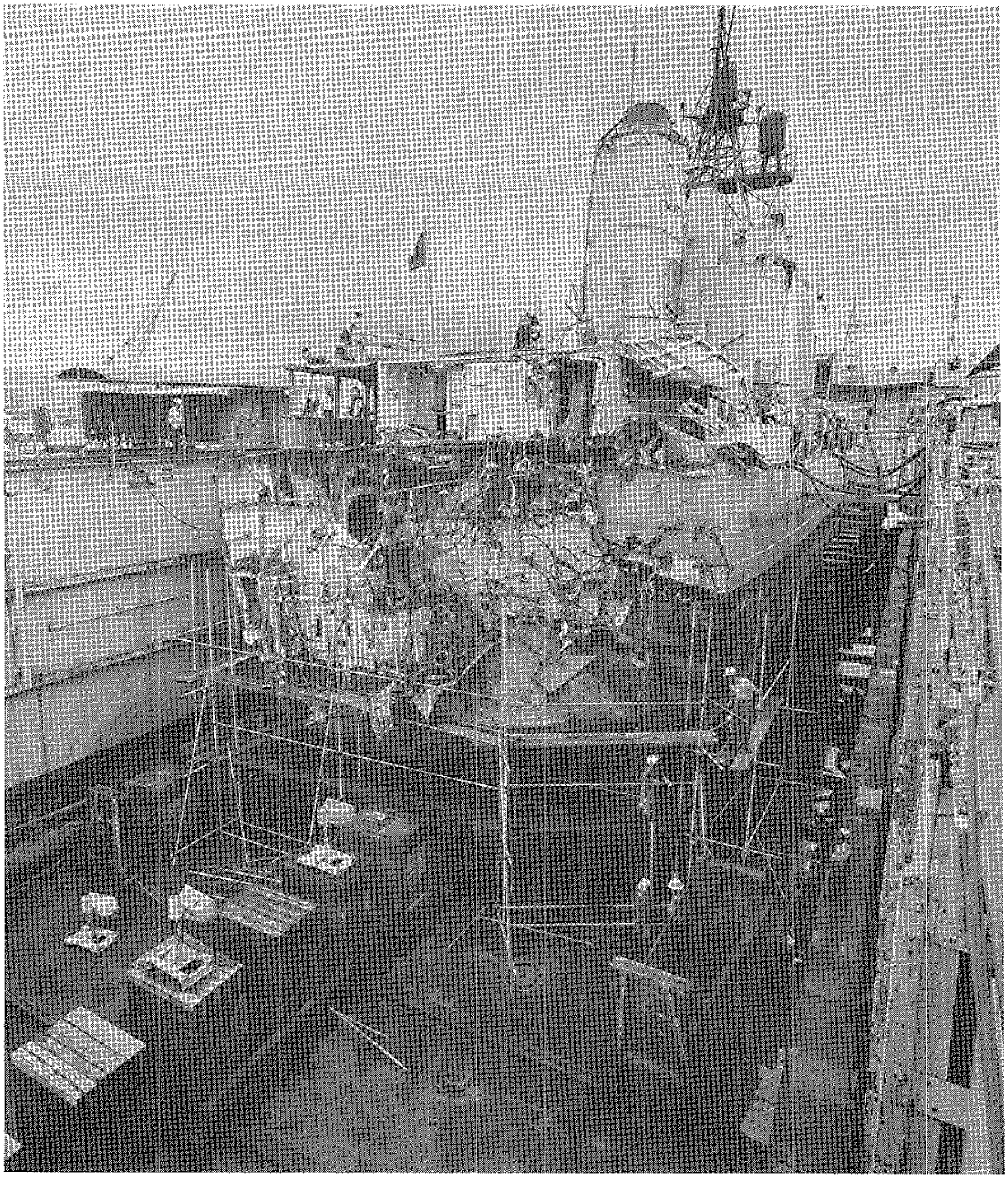
CONCLUSIONS

The successful salvage of the SS ALAMO VICTORY points again to the importance of thorough planning and vigorous application of means to the task. Progress throughout the various stages was smooth and uninterrupted except for occasional delays encountered in the dredging operations. In this regard, dredging activity was halted several times to clear debris caught in the dredge's cutter blade. Future dredging operations under similar circumstances should take into consideration the use of a much larger cutter blade for greater effectiveness and efficiency.

SALVAGE AND TOWING

OF

USS FRANK E. EVANS (DD-754)



Severed stern section of the EVANS was successfully towed from collision site in the South China Seas to Subic Bay, Philippines – a distance of 825 miles.

EVANS IN DRYDOCK AT SUBIC BAY, PHILIPPINES

SALVAGE AND TOWING
OF
USS FRANK E. EVANS (DD-754)

INTRODUCTION

The Australian aircraft carrier, HMAS MELBOURNE, collided with USS FRANK E. EVANS (DD-754) in the South China Sea on 2 June 1969. The impact of the collision cut the American destroyer in two. Her bow section, with 72 crew members aboard, sank within a few minutes, beyond recovery at a depth of 200 fathoms. MELBOURNE rescued the remaining personnel. The stern section, although still afloat, wallowed in the open sea in imminent danger of flooding, capsizing and sinking.

USS EVERETT F. LARSON (DD-830) reached the scene first, followed shortly thereafter by USS TAWASA (ATF-92). LARSON took immediate action to secure the stern section and keep it afloat, TAWASA joining in these efforts upon her arrival. The two ships then prepared the hulk for tow. Recovery operations culminated in a successful tow by TAWASA to Subic Bay, Philippines, 825 miles from the collision site.

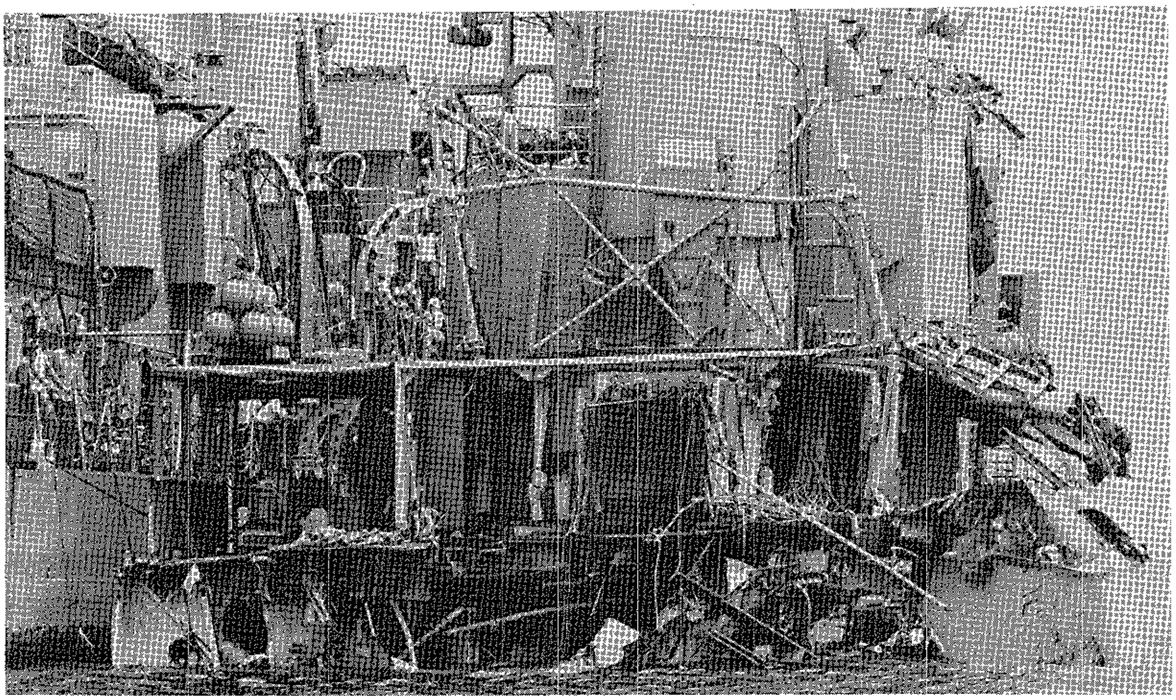
IMMEDIATE SALVAGE ACTIONS

Condition of the Stern Section

The terrific impact of the collision severed the destroyer through the forward engine room. However, its knifelike thrust also confined massive damage and hull deformation to the immediate area of impact. Remarkably, even the after bulkhead of the exposed engine room withstood the collision, with only minor leakage evident. Elsewhere, the stern section remained essentially intact and stable.

Coordinated Damage Control Efforts

LARSON immediately took the drifting stern section alongside and made it secure. Crew members then went aboard and initiated damage control actions to seal off flooded areas and ensure the watertight integrity of dry spaces. TAWASA arrived while this initial work was in progress and dispatched trained salvage personnel to reinforce the LARSON's efforts and survey the extent of damage. Pumping was undertaken to control flooding in the after fireroom. Classified documents, personnel records and similar items were recovered and transferred to LARSON.



Damage extended no further than two frames from the stern's severance point and hull deformation was confined mainly to the area of impact.

CLOSEUP VIEW OF DAMAGE SUSTAINED TO STERN OF EVANS

The two crews worked intensively and efficiently for 16 hours to control the damage. Their joint efforts brought the hulk to an almost even keel, with drafts reading 12 feet at the stern and 18 feet at the collision line. Stability, control and safety features were judged to be ample and adequate for towing operations.

PREPARATIONS FOR TOWING

Major Preparatory Actions

TAWASA made the following preparations, working throughout the night of 4 June to complete the work:

1. Removable topside equipment, including the port torpedo mount, was jettisoned in order to increase stability to lowering the hulk's center of gravity. The ship's variable depth sonar (VDS) equipment was housed securely on deck.

2. Two 3-inch pumps were installed and flood alarms were rigged in machinery spaces for contingency use.

3. The ship's shaft alleys were pumped dry and packing glands on the shafts were taken up. This action was taken to reduce the flooding into these spaces that is normally controlled with overboard discharge pumps.

4. Shafts were locked as an additional measure to control flooding. The rudder was also locked on the centerline to ensure that it would not impede towing action.

5. A long section of steam piping protruding from the after bulkhead of the forward engine room was removed and the opening sealed off. This bulkhead was the primary flooding boundary. Removal of the pipe was essential to preclude its moving about in the wake of the tow and thereby weakening the bulkhead. Attempts were then made to remove other less critical trailing wreckage but were forestalled by worsening sea conditions.

Related Preparations

A clean-up party removed all debris from the ship that could cause hazardous gas formations. A Jacob's ladder was rigged over the side to facilitate boarding by inspection parties during the tow. Soundings were taken in all bilges and voids. The water levels in the bilge tanks were determined to be near the optimum for stability.

Rigging for the Tow

EVANS was rigged for towing stern first with the tow point at the deck base of her gun mount. A length of 1-5/8-inch diameter wire rope was looped a full turn around the base ring of the gun mount. The ends of the wire rope were then brought aft and fastened to the towing bridle on the fantail with plate shackles.

The bridle was then connected to the towing hawser by fairleading through the stern chocks. This arrangement bypassed the bitts, located outboard on the fantail, providing a straightforward pull for the towing effort.

CONDUCT OF THE TOW TO SUBIC BAY

TAWASA got underway for Subic Bay on 5 June with the EVANS in tow. Salvage parties boarded the hulk twice each day during the voyage to inspect for new damage and take preventive action. The tug made the 825-mile trip in six days, encountering no major problems enroute.

TAWASA did lose her tow on 8 June when the chain section in the towing hawser parted. However, the tug recovered the hawser, maneuvered alongside EVANS and reconnected it to the towing rig aboard the hulk without difficulty.

The daily inspections proved to be prudent as the salvage parties discovered a series of small leaks and sealed them before they could spread. They also detected a potentially serious leak through a broken flange on a wye connection in an overboard drain line. The wye connection was immediately removed and the three lines leading from it were blanked off.

EVANS tended to crab slightly while under tow. This tendency, apparently caused by the trailing wreckage, created some concern within the inspection parties, because it produced chafing in the towing pendant. The condition did not deteriorate, however, and no modifications to the rig were needed.

AFTERMATH

Rebuilding the EVANS was eventually judged to be impractical. Accordingly, the destroyer was stricken from the Naval Vessel Register and all recoverable equipment removed. The stern section was then sunk by Naval gunfire on 10 October 1969.

CONCLUSIONS

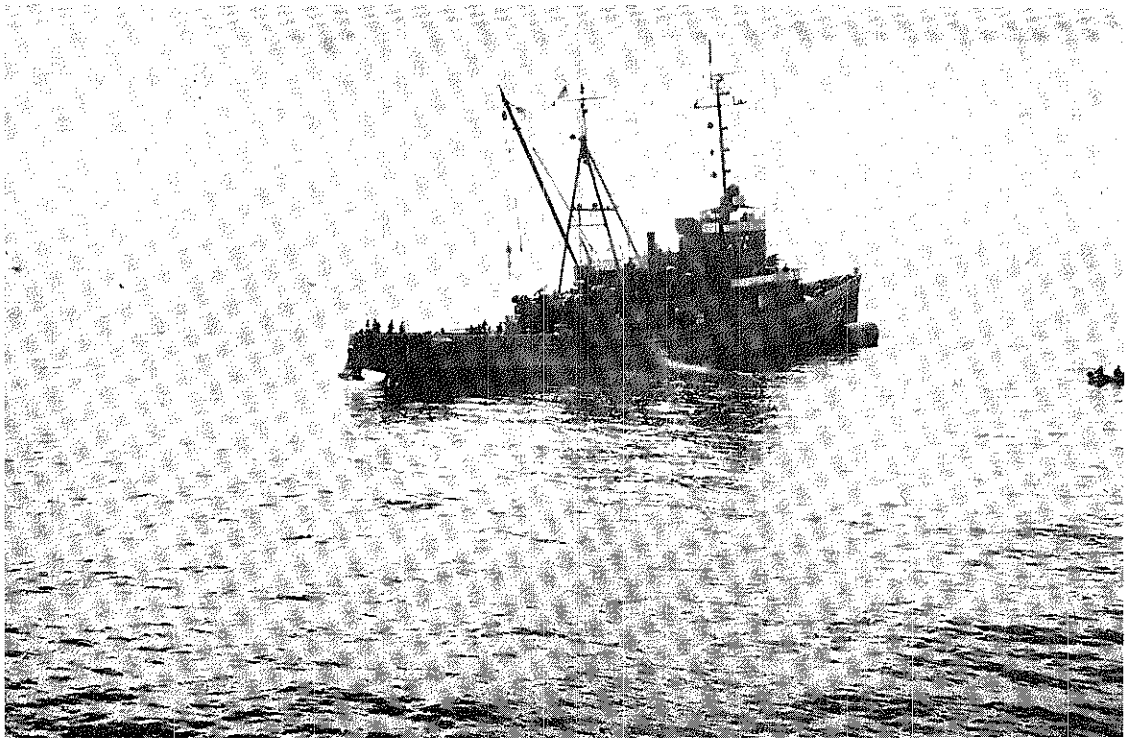
The actions of both LARSON and TAWASA were highly effective in this operation. LARSON's crew, although not trained in sophisticated salvage techniques, moved immediately to gain initial control over the drifting hulk. Their efforts succeeded because they knew and applied fundamental principles of seamanship and basic damage control procedures. TAWASA's salvage personnel added the expertise necessary to stabilize the ship, prepare it for towing and conduct the tow over major distances in the open sea.

Methods such as establishing watertight boundaries, pumping, jettisoning, sealing leaks are familiar and well established. They worked well in this operation because they were used in concert. That they were used in concert is testimony to the planning skills and leadership abilities of the officers and petty officers who directed the recovery and towing efforts.

SALVAGE

OF

GROUNDED VESSEL
SS NORWICH VICTORY



CHOWANOC was one of many vessels engaged in the successful salvage of the NORWICH VICTORY. Extrication of the stricken vessel was remarkable in that it was freed without sustaining further damage to its hull.

**USS CHOWANOC PREPARES TO ASSIST IN
THE SALVAGE OF THE NORWICH VICTORY**

SALVAGE OF GROUNDED VESSEL
SS NORWICH VICTORY

INTRODUCTION

SS NORWICH VICTORY, a U.S. Government-owned vessel, ran hard aground on 25 September 1969 on a coral reef off Triton Island (Paracell Island Group) while enroute to South Viet Nam. At the time, she was carrying 4,960 long tons of ammunition and 8,900 barrels of fuel oil. Fortunately, NORWICH VICTORY sustained negligible outer structural damage in the stranding, thus saving her from severe flooding of any kind. No cargo or oil was lost in the accident and there were no personnel injuries.

Assistance was immediately called for and received. Among the ships and other craft assigned to and engaged in the salvage operations which followed were: USS CONSERVER (ARS-39), USS CHOWANOC (ATF-100), USS GRAPPLE (ARS-7), and USS GRASP (ARS-24), plus several barges and tugs. LCDR J. J. Goodwin assumed overall operational responsibility upon being designated Salvage Officer by the Supervisor of Salvage.

The effects of both extensive use of beach gear and steady cargo offloading were sufficient to overcome the resistance of the grounded vessel, so that on 8 October 1969 NORWICH VICTORY broke from its entrenched position free and afloat. Hull damage was found to be remarkably light following extrication which allowed NORWICH VICTORY to proceed under her own power to Danang for a more thorough inspection. Hull inspection at Danang showed that the ship was seaworthy, and she was then ordered to sail on to Yokohama, Japan, for completion of repairs.

THE SALVAGE PLAN

Grounded Condition of the Vessel

NORWICH VICTORY was hard aground from bow to engine room, with hull visible to the bilges. More specifically, the ship was aground 42 feet from fo'c'sle, followed by a 93-foot span with water under the hull and a 90-foot span on the coral reef. The remaining portion of the ship was free. Onboard inspection showed that no flooding, cargo damage, or oil leakage had occurred; and an underwater survey of the hull revealed little or no structural damage to the ship. Draft readings before grounding were: FWD – 22 feet; AFT – 25 feet 6 inches. Draft readings after grounding showed: FWD – 9 feet; MIDSHIP – 26 feet; AFT – 32 feet 6 inches.

Salvage Approach

To offset and overcome the forces which held the NORWICH VICTORY firmly aground, three distinct actions were called for, namely:

1. Use of up to eight sets of beach gear
2. Offloading of ammunition
3. Transfer of fuel oil from forward to aft tanks.

Implementation would take into consideration the rigging of four sets of beach gear on the grounded vessel and two sets each on the CONSERVER and CHOWANOC. Cargo offloading would be accomplished by Navy hatch teams, with barges, tugs and other support craft being used to haul materials away from the area. An estimated minimum of 2,000 tons of cargo would have to be unloaded to meet the demands of the undertaking.

THE SALVAGE OPERATION

Salvage operations commenced on September 28, with two sets of beach gear being laid from NORWICH VICTORY and a tow wire being run to CONSERVER. Wrenching action ensued in which NORWICH VICTORY took alternate strains on her beach gear legs as CONSERVER maintained a steady pull on the tow wire, but results in this effort were completely negative. CHOWANOC then laid two more sets of beach gear from NORWICH VICTORY in preparation for a second wrenching attempt on September 30. This attempt also failed, and succeeded only in dragging four of the six beach gear anchors from their positions. These were reset by CHOWANOC and tested again for strength and solidity.

While the above noted activity was in process, offloading of cargo was well underway. Dangers posed by the nature of the cargo (ammunition) and inability of forklift trucks to maneuver between decks of the ship slowed the offloading rate considerably. Nevertheless, by early morning on October 2, over 400 tons of ammunition were off the vessel. To expedite action in this regard, 4,000-pound, short-masted electric forklift trucks were ordered and received on 2 October.

Following the two wrenching attempts noted above, a diving survey of the NORWICH VICTORY was conducted which showed the ship to be hardest aground under numbers 1 and 2 holds from port of centerline to starboard bilge and from midpoint of number 3 hold to 27 feet aft of the midship perpendicular. Bottom plating was bent and ashboarded. A check of the double bottom near one starboard tank revealed that it was taking water, as were tanks near the bottom centerline and at the starboard side. Flooding threat, however, was adequately controlled by the ship's pumps. Compressed air was on hand for blowout of tanks in the event that pumping should fail.

Weather deteriorated on 2 October which hampered the salvage operations. Nevertheless, CHOWANOC laid an additional set of beach gear for CONSERVER in preparation for another wrenching and pulling attempt at high tide, an effort which subsequently succeeded in moving the NORWICH VICTORY some 25 to 30 feet to port. Wrenching ceased at low tide, but an even strain was maintained on all beach gear until the next try at high tide. Results in the latter case were far from satisfactory in that during that particular attempt the 1-5/8-inch pendant on the tow wire from CONSERVER to NORWICH VICTORY parted, making it necessary to halt pulling operations for repairs.

On 4 October USS GRASP arrived on the scene and immediately prepared to lay beach gear for the next pull. Weather worsened considerably at this time, causing a two-day delay in the operations. On 6 October adverse weather conditions abated which allowed GRASP to begin laying two legs of beach gear. In the process, while attempting to get into harness after dark, the tow wire was caught in her port screw which required unwrapping by means of screw handjacking. This caused further delay of operations and postponement of activity until the next day.

On 8 October success was realized. As NORWICH VICTORY, CONSERVER, and GRASP each pulled full power on their respective beach gear, the stranded vessel extracted smoothly from its entrenched position. On reaching proper water depth, NORWICH VICTORY and CONSERVER let go their beach gear as GRASP continued to tow the vessel approximately five miles out to sea. Immediate inspection showed that NORWICH VICTORY could proceed under her own power to Danang, with GRASP in escort, for a determination of actual damage sustained.

It should be noted that a total of 1,875 tons of cargo was offloaded during the operations. This in itself is remarkable considering the many delays encountered due to adverse weather conditions and the limitations imposed by equipment used.

Hull inspection at Danang revealed that the number 1 double bottom, from frames 14 to 37, had severe dishing and some splits and that the port and starboard tanks were taking water. Number 2 double bottom, from frames 37 to 52, was less severely damaged, although the centerline and starboard tanks were also taking water. No other damage was noted. NORWICH VICTORY then proceeded to Yokohama, Japan for needed repairs.

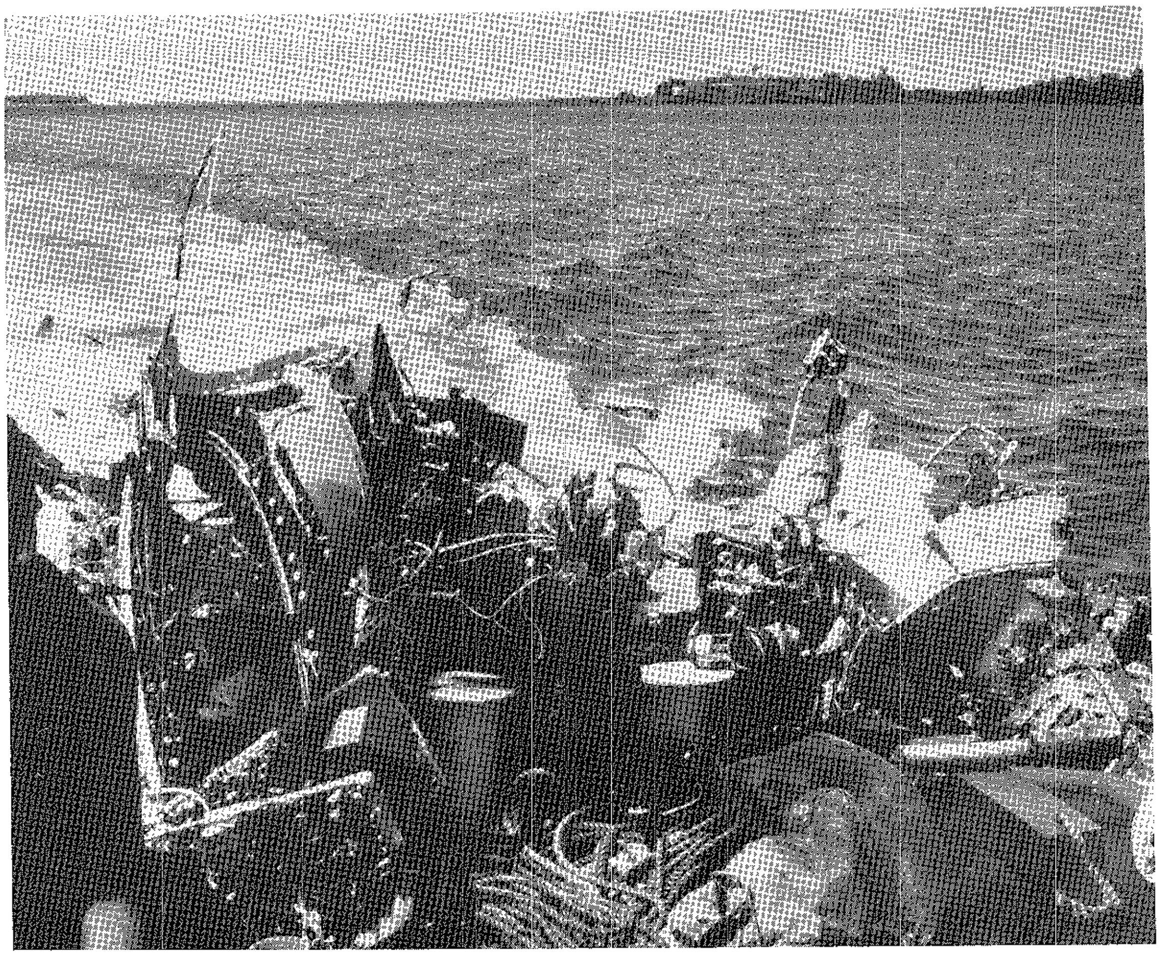
CONCLUSIONS

Successful refloating of the NORWICH VICTORY attests to the competence of those who engaged in the operations and to the soundness of the salvage plan. Noteworthy in this endeavor is the fact that expeditious extrication was achieved without the NORWICH VICTORY sustaining any further damage. To those who completed the difficult and hazardous task of offloading the cargo goes the highest praise, since the occurrence of an accident in this area of the operations would surely have been disastrous.

AIRCRAFT

SEARCH AND RECOVERY

ACTIVITIES



Several aircraft search and recovery operations were conducted throughout 1969 in response to requests for assistance made by other government agencies and by the civilian sector of the aircraft industry. Water depths ranged from 65 to 600 feet among the various operations.

RECOVERED AIRCRAFT WRECKAGE BEING HAULED AWAY FROM IMPACT SITE

AIRCRAFT SEARCH AND RECOVERY ACTIVITIES

INTRODUCTION

Whenever and wherever possible, the Office of the Supervisor of Salvage extends the use of its facilities and resources to areas of activity not normally associated with it. Throughout the year 1969, as in previous years, numerous inquiries and requests for assistance were directed to the Office in connection with downed aircraft. Responses to these calls varied according to the circumstances and ranged in scope and degree of importance and complexity as the demands dictated. In some cases, advisory opinions and recommendations were the only requirements; in others, full-scale on-site operational support was the order of the day.

This article summarizes the services provided by the Office of the Supervisor of Salvage in connection with operations to locate and recover five different downed aircraft. Three were military jet aircraft, one a civilian jet airliner, one a military helicopter. Each presented unique salvage problems. Together, they reflect the scope and diversity of services required to execute recovery operations of this type.

Each of the following operations is summarized in this article:

TYPE AIRCRAFT	LOCATION OF CRASH
U.S. Navy A-4F	**Off Vandenburg AFB, California**
U.S. Air Force T-33	**In Lake Superior off Duluth AFB**
U.S. Air Force HH-53C	**Off Elgin AFB, Florida**
Scandinavian Airline DC-8	**Off Los Angeles, California**
U.S. Air Force F-106	**Lake Garrison, North Dakota**

U.S. NAVY A-4F AIRCRAFT

Date: 24 April 1969
Location: Off Vandenburg AFB, California
Condition: Lost in about 200 feet of water
Task: Salvage feasibility study

Background

This aircraft was flying in formation with two other planes off the coast of Purisma Point, California, when an apparent violent engine failure caused it to plunge into the sea about five miles from shore. The plane disintegrated on impact and the pilot, who did not eject, was lost. Subsequent search efforts, which covered a period of 13 days, concentrated on locating the major structural fragments of the wreckage, in particular, the engine and the frame. In this endeavor, two surface vessels, the USS LEADER (MSO 490) and the USS ILLUSIVE (MSO 448), were utilized. Each was equipped with shadowgraph sonar devices capable of developing underwater contact and dispersal patterns which could be used to determine to a reasonable degree the possible location of the wreckage.

By 8 May 1969, a high confidence shadowgraph sonar target was established and preparations for recovery were set in motion. In order to ascertain the feasibility of such an undertaking, the Commander Naval Air Force, Pacific, requested the services of the Office of the Supervisor of Salvage which would: 1) evaluate information gathered; 2) report on feasibility of salvage; and 3) set forth recommendations for recovery, if this was practicable. The Supervisor of Salvage responded affirmatively to the request and immediately assigned the task to a commercial company, Ocean Systems, Incorporated (OSI).

Situation Survey and Evaluation

Review of shadowgraph sonar records, hydrographic information, and aircraft fixes taken at the time of the accident led to refined modifications of the "prime search area" calculated by those who had engaged in the on-site search operations. On the basis of available data, a two-mile square prime search area, two miles due west of Purisma Point, California, was designated as having the highest potential for recovery of the wreckage sought. Analysis of ocean bottom characteristics and water currents showed that conditions were favorable for use of towed sidescan sonar search (a more reliable method than shadowgraph sonar) or trawler drag search.

Recommended Recovery Approaches

Three approaches to the problem were formulated by the Supervisor of Salvage as follows:

1. Utilize towed sidescan sonar (estimated probability of success, 90%). Contacts would be verified by remotely controlled, tethered TV camera with topside monitor and video tape recorder. Recovery would be accomplished by divers. Estimated operational time: four days.
2. Use of technology noted in (1) above, but for a lesser time period (three days). Probability of success, 55%.
3. Use of a trawler-type fishing vessel and shore-based precision navigation (estimated probability of success, 40%). Operational time: about seven days.

The first approach was strongly recommended by the Supervisor of Salvage.

Final Disposition of Survey/Analysis Investigation

Recommendations and advice developed in the course of this investigation were forwarded to the Commander Naval Air Force, Pacific for review and consideration. After due deliberation, a decision was reached to terminate all activity in this matter since funds were not available to carry out the project.

U.S. AIR FORCE T-33 JET AIRCRAFT TRAINER

Date: 24 September 1969
Location: Lake Superior
Condition: Lost in 100 feet of water
Task: Recover remains of pilot

Background

Subject aircraft crashed while on a routine training mission out of Duluth Air Force Base, with loss of pilot. Base radarscope tracking showed disappearance at a point about eight miles from the home station and over Lake Superior. The U.S. Coast Guard was immediately contacted and sped to the suspected area where they sighted a small, almost unnoticeable oil slick and a section of a wing tip tank floating nearby. Site was marked for further exploration.

An immediate investigation was launched by the 343 Fighter Group Accident Investigation Board which quickly outlined priorities as follows: 1) recovery of the remains of the pilot; and 2) evaluation of the situation with regard to possible recovery of the wreckage. To accomplish these two objectives, the Board obtained the services of the Office of the Supervisor of Salvage. The Supervisor of Salvage, in turn, assigned the task under contract to Ocean Systems, Incorporated (OSI), with instructions to provide the necessary personnel, equipment, bottom search diving and recovery systems, and other navigational aids. U.S. Coast Guard assistance would be rendered in the form of a buoy tender (USCG WOODBRUSH), which was to be used as a diving and salvage platform in the operations.

Search and Recovery Operations

The salvage plan was simple in concept, employing these two basic tactics:

1. WOODBRUSH would develop a contact and dispersal pattern over the crash area using E. G. & G. sidescan sonar devices.
2. Diver investigations would follow at points strongly recorded by the sonar devices.

Active sonar search commenced 29 September 1969. Within two days, aircraft debris patterns were obtained which indicated the most likely location of the wreckage. On the basis of this data, diver investigations confirmed the reliability of the readings and, indeed, the location of the heaviest concentration of debris was found, including the engine. For the next four days, active and energetic recovery operations succeeded in reclaiming approximately 65% of the aircraft debris and the remains of the pilot. Salvage operations terminated on 4 October 1969.

Conclusions

Prompt action taken to pinpoint the crash site immediately following disappearance of the plane effectively aided subsequent activities in this case and helped to bring about positive results within a relatively short period of time. The successful outcome in this instance pointedly illustrates the effectiveness of inter-service participation and cooperation, clearly shown throughout the operations.

U.S. AIR FORCE HH-53C HELICOPTER

Date: 8 October 1969
Location: Off Elgin AFB, Florida
Condition: Lost in about 360 feet of water
Task: Search and recovery

Background

This helicopter exploded in mid-flight while on a routine combat training mission and plunged into the sea at the above noted location and water depth. Destruction was complete and fragments quickly sank to the ocean bottom. The crash site was identified by a smoke marker minutes after the craft hit the water. Three crew members were killed in the accident.

In positive response to the U.S. Air Force request for immediate assistance that followed, the Supervisor of Salvage designated Ocean Systems, Incorporated (OSI) to provide the services and materiel needed to accomplish wreckage search and recovery. On receipt of notice, OSI promptly mobilized a search and recovery unit consisting of a motor vessel, the M/V STATE POINT, which would be used as a search platform; an ADS-IV diving system; E. G. & G. sonar; the services of off-shore Raydist, Incorporated; and a television identification assembly. By 14 October 1969, full-scale operations were underway.

Operational Search and Recovery

Several contacts were made using the above devices and equipment which were confirmed by divers working out of the ADS-IV. By 16 November, recovery of major components was accomplished, among these being the landing gear, tail rotor instrument panel, and the No. 2 engine and gear. Operations ceased on 16 November due to depletion of available funds.

Conclusions

Recovery of the major components of the helicopter from depths ranging up to 500 feet marks this operation as a high-performance accomplishment. Delays did occur due to intermittent adverse weather conditions, but this did not deter the energetic pursuit of the objectives set forth in the operational plan.

SCANDINAVIAN AIRLINE SYSTEM (SAS) DC-8 JETLINER

Date: 14 January 1969
Location: Off Los Angeles, California
Condition: Sections submerged
Task: Recovery of flight recorder

Background

Subject commercial airliner crashed suddenly at sea with 45 persons aboard while making an approach for landing at Los Angeles International Airport. Fuselage broke in two on impact and tail section immediately sank in approximately 600 feet of water. Forward section remained afloat and was later towed to shallower waters where it too dropped to the ocean bottom. U.S. Coast Guard cutters and helicopters arrived on the scene shortly thereafter and picked up 30 survivors.

Proper evaluation of the circumstances of the loss required the recovery of the flight recorder which was located in the sunken tail section. In this regard, the National Transportation Safety Board, which launched an immediate investigation following the crash, requested and promptly received the assistance of the Office of the Supervisor of Salvage.

Search Operational Activity

Three surface vessels [USS CONFLICT (MSO 426); USS REAPER (MSO 467); USNS GEAR (ARS 35)] were used to run sonar search patterns over the impact area. A two-day effort by these ships produced negative results, principally because of the relative operational ineffectiveness of the sonar devices in extreme water depths. A deep submersible vehicle, Lockheed's DEEP QUEST, was then brought into service and succeeded in locating the engine, landing gear, and the tail section.

Tail section recovery action at this point was temporarily deferred pending the results of salvage plan discussions held among all interested parties. A decision was reached which gave Lockheed Corporation the responsibility for recovering the tail section and the flight recorder, thus ending Navy participation in the salvage operations.

Salvage Outcome

Subsequent attempts at raising the tail section failed. However, the flight recorder was found by DEEP QUEST some distance away from tail wreckage and later recovered.

U.S. AIR FORCE F-106 AIRCRAFT

Date: 10 March 1969
Location: Lake Garrison Reservoir, North Dakota
Condition: Lost in 65 feet of water
Task: Search and recovery

Background

This aircraft developed in-flight control problems while flying on routine duty and as a result crashed at high speed into the ice-covered Lake Garrison Reservoir a mile from shore. Pilot ejected safely. Plane disintegrated on impact, with debris scattering out over the ice at distances up to 500 yards. Engine and other components were thrust through the thin ice and sank to the bottom. Water quickly froze over at the point of penetration.

On 13 March 1969, the Office of the Supervisor of Salvage was asked by the U.S. Air Force to assist in recovery of the debris and of any major components which might be intact on the reservoir bottom. The Supervisor of Salvage responded to the request by assigning the task to Ocean Systems, Incorporated (OSI).

Search and Salvage Operations

A helicopter survey of the impact area was made to determine the general conditions under which operations would be conducted. It was concluded that a major recovery effort at this point in time would have to be postponed since heavy equipment use over thin ice would present too great a risk, and that current attempts should be confined to:

1. Diver inspection and search.
2. Recovery of as many items as possible under the limitations imposed by the conditions (e.g., in the absence of heavy equipment), with emphasis being placed on retrieving surface control activators and hydraulic control valves.

A four-day limit was set for accomplishing the above noted activities. At the outset, a 3- by 6-foot access hole was cut in the ice at impact point to allow divers to descend to the bottom. Subsequent underwater inspections, carried out under difficult conditions (poor visibility, mud accumulations, freezing water) revealed the extent of the disintegration of the aircraft. During the four-day operational period only one hydraulic activator was found and recovered, and only one rudder activator with control valve. All other debris brought to the surface was almost unrecognizable at first glance. Engine was found directly beneath impact point, but could not be lifted at this time. On 21 March 1969, operations ceased with only partial success.

Conclusions

As noted in the discussion above, full-scale operational activity was restricted by the physical conditions at the site. It was suggested that anticipated resumption of recovery efforts after the spring thaw should take into consideration a drag-line and/or clamshell bucket approach to the problem.