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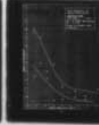
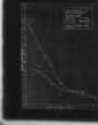
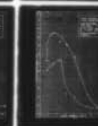
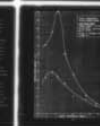
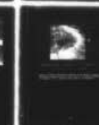
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PROJECT CHEESEBOX: A JOURNEY INTO HISTORY. VOLUME III. (U)  
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# Project Cheesebox

A journey into history

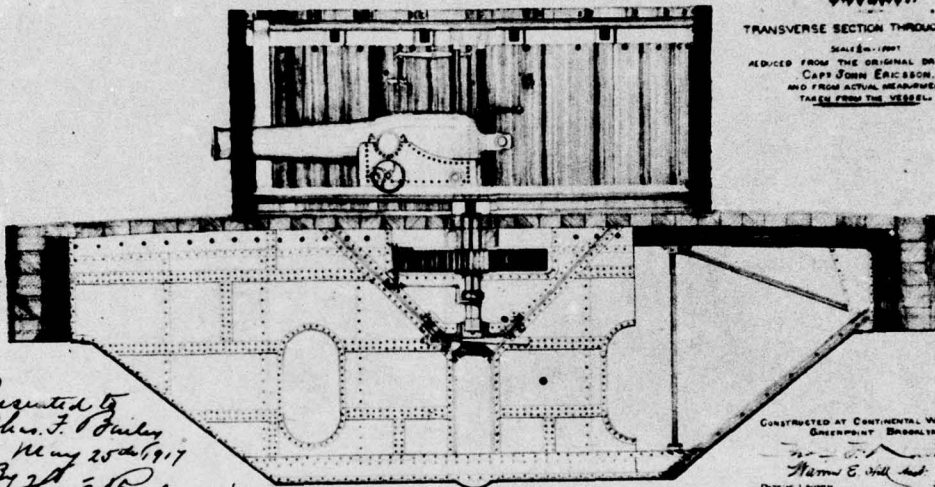
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U. S. Iron Clad Gunboat  
Monitor.

TRANSVERSE SECTION THROUGH TURRET

SCALE 1/4" = 1' 00"

REDUCED FROM THE ORIGINAL DRAWINGS OF  
CAPT JOHN ERICSSON,  
AND FROM ACTUAL MEASUREMENTS  
TAKEN FROM THE VESSEL.



Presented to  
Chas. F. Bailey  
May 25th 1917  
By J. P. Rowland & Co.

CONSTRUCTED AT CONTINENTAL WORKS,  
GREENPOINT, BROOKLYN, N. Y.

Wm. E. Hill, Jr.  
DATE OF DRAWING: JULY 20th 1862  
DATE OF MEASUREMENT WITH MONITOR: MARCH 27th 1862



Volume Three

DISTRIBUTION STATEMENT A  
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Research Manuscript

United States Naval Academy  
1974

11  
Dec 74

12  
342 p.

6  
PROJECT CHEESEBOX:  
A JOURNEY INTO HISTORY.  
Volume III.

9 A Research Manuscript,  
Department of History  
United States Naval Academy  
Annapolis, Maryland

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W. M. Darden, History Department, U. S. Naval Academy, Annapolis, MD

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#### EDITOR'S NOTE

After much planning, a joint expedition headed by Mr. John Newton of Duke University and Mr. Gordon Watts of the State of North Carolina was organized. They had completed an historical inquiry into the sinking and had also designated an historical sinking site.

The expedition was funded by the National Geographic Society and the National Science Foundation and would utilize the Duke University Research Vessel Eastward. Dr. Harold E. Edgerton was instrumental in initiating the venture and would prove his experience and equipment to be indispensable to the effort.

This expedition produced the first photographic evidence of a wreck which held great promise of being Monitor. Endless hours were spent studying the video tapes, producing little conclusive evidence that the wreck was Monitor. Members of the expedition seemed to be convinced and several interesting artists conceptions of the wreck were drawn, however, a public bombarded with 25 years of claims of discovery would require better proof than that obtained to date.

Final positive identification would have to wait until the April 1974 voyage of the Alcoa Seaprobe and the resulting mosaic.

FINAL EXPEDITION REPORT - CRUISE E-12-73

by

Mr. John G. Newton  
Duke University Marine Laboratory  
on Behalf of Coinvestigators

Dr. Harold E. Edgerton  
Massachusetts Institute of Technology

Dr. Robert E. Sheridan  
University of Delaware

Mr. Gordon P. Watts  
North Carolina Division of Archives and History

Expedition Vessels:

Research Vessel EASTWARD provided by Oceanographic Program  
Duke University Marine  
Laboratory

Landing Craft Utility 1488 provided by 824th Transportation Company  
J Boat 3589 U. S. Army Reserve

This report is included in this research manuscript by permission of John G. Newton.

## ABSTRACT

An oceanographic expedition off North Carolina in August 1973 had dual objectives: 1) the geological study of a ridge and swale on the Continental Shelf off Cape Hatteras, 2) a search for the Civil War ironclad U.S.S. MONITOR.

Two weeks of ideal weather and a group of diverse, but compatible specialists aboard three vessels, brought both goals to successful conclusions. The geological study offered evidence of ancient estuarine environments, buried channels and upwarping of strata beneath the ridge. The archaeological search yielded more than twenty-two contacts in the area of interest which were detected by side searching sonar, vertical sonar, or magnetometer. Two of these targets were selected for thorough investigation by photographic and television cameras. One target was revealed to be a fishing trawler; the second has been identified as the wreck of the ironclad U.S.S. MONITOR.

## OBJECTIVES

During the period August 17-31, 1973 the research vessel EASTWARD and Army Reserve vessels conducted a combined geological and archaeological study off Cape Hatteras. These two projects were compatible because they shared a common area and because the equipment needs were almost identical (i.e., magnetometer, side scan sonar, vertical sonars, seismic reflection profiler, precision navigation system, underwater

photographic cameras and underwater television).

A team of geologists, archaeologists, historians, preservationists, electrical engineers, and navigation specialists worked in harmony during the cruise, bringing to bear on the studies an impressive array of sampling, analytical and observational equipment. The weather was excellent, providing a rare example of two weeks of almost flat calm. As a consequence, cruise results exceeded the greatest expectations.

#### PLANNING, PREPARATION, AND SUPPORT

A ship use proposal for the research vessel EASTWARD was submitted on February 28, 1973 to the Cooperative Oceanographic Program of Duke University Marine Laboratory. Coinvestigators in this ship time request were Dr. Harold Edgerton, Dr. Robert Sheridan, Mr. Gordon Watts and Mr. John Newton. The request was reviewed and approved by a panel devised by the National Science Foundation. This approval for ship use was confirmed by letter on March 13, 1973.

#### Equipment Support

Dr. Edgerton submitted a proposal for side-scan sonar support to the National Geographic Society in March 1973. Mr. Newton submitted a similar request for other equipment support (including lease of vibracorer), contractual services and reproduction costs to the Society on April 9, 1973. Letters confirming funding of both proposals were received in mid-May, 1973.

## Logistics Support

Letters requesting Army Reserve support were sent to Captain Larry Hardy of the 824th Transportation Company (Heavy Boat) and Captain Wallace of the 650th Transportation Company. With General Thomas Thorne's concurrence, formal approval for use of a Landing Craft Utility (LCU), J Boat and twenty-ton crane was received in late July. The LCU and twenty-ton crane were intended for use in vibracoring the ridge and trough, as a major contribution to the geological study. The LCU also had good anchoring capability; a stern winch with one thousand feet of wire and a large kedge anchor offered good holding power. Excellent positioning capability was provided by three screws. The J Boat was an ideal logistics vehicle for ferrying personnel and small pieces of equipment to and from the other two vessels. The U. S. Army Reserve 824th Transportation Company provided skeleton crews for the Army vessels, rotating the crews for relief at approximately five day intervals. The crews on the Army vessels were supplemented by vacationing personnel from Duke University Marine Laboratory and others hired on a contractual basis for the expedition.

## EQUIPMENT

The expedition involved a large variety of hardware and several navigation techniques which are described as follows:

1) Sonars and geophysical gear

Side Scan, 105 Khz., EG&G type 259  
Basic, 38 Khz., Simrad  
Vertical, 12 Khz., Edo with Precision Fathometer  
Recorder, Raytheon  
Vertical, 7 Khz., EG&G  
Vertical, 5 Khz., Edo  
Pinger, 12 Khz., EG&G  
Bolt Air Gun Seismic Reflection Profiler  
Magnetometer, Proton Precession, Varian

2) Navigation

Transponders and Receiver, Del Norti  
Loran A and C Receivers  
Omega Receiver  
Radar Ranges and Visual Bearings  
Horizontal Sextant Angles  
Bathymetric Control using recent NOAA/C&GS data  
Buoys

3) Television and Photography

Underwater Television, Hydro Products, with one inch  
PVC Recorder  
Underwater Camera, EG&G, 204, 205  
Underwater Camera, Alpine Geophysical Associates

4) Over-the-side Sampling Gear

Dredge, University of Cape Town  
Grapple Hook

5) Analytical Gear

Current Meter, Hydro Products

GEOLOGICAL STUDY

Origin of the Ridge and Swale

Bathymetric work in compiling An Oceanographic Atlas of the Carolina Continental Margin had revealed a ridge and swale (trough) on the North Carolina continental shelf twelve miles south of Ocracoke Inlet. The ridge (later studies revealed

two ridges) has a maximum relief of seventy-two feet and both features are elongated in a northeast-southwest direction, parallel to the coastline. In relief and geographic extent this shoal represents one of the larger features on the U. S. Atlantic continental shelf south of Delaware.

It was hoped that a geomorphic study of the ridge and swale would provide information from which the origin of similar features on the Atlantic shelf could be generalized. The question of origin concerned two possibilities:

- 1) Is the ridge a surface reflection of a subsurface structural feature,
- or
- 2) is it a sedimentary feature lying on an abraded surface of an older sea floor?

#### Techniques

The geomorphic study was given first priority because of the complexity of equipment to be employed in the work. The vibracorer, for example, required sea state 2 or less for efficient operation.

On arrival in the Hatteras area, R/V EASTWARD commenced vertical and side-scan sonar surveys of the ridge and trough. The seismic reflection profiler was operated simultaneously. A series of northwest-southeast profiles were run, perpendicular to the orientation of the ridge and swale surface contours. The subbottom profiles were plotted and interpreted as the survey progressed. When enough base data were accumulated to visualize the general nature of the ridge, Dr. Sheridan

and the University of Delaware technicians transferred to LCU 1488 to commence vibracoring. The positions of the eleven vibracore sites were determined through interpretation of the seismic records. Each vibracore reached approximately twenty feet below the surface. Credit for the efficiency of this coring program, which was completed in a record time of thirty-seven hours, is due largely to the prior assembly and check-out of the vibracore system by Mr. Stockel and the efforts exerted by him, the crew of the LCU and men of Dr. Sheridan's group, whose round-the-clock labors proved to be crucial in the success of the expedition.

Near the end of the geological study, the LCU occupied current meter stations on each side of the main ridge.

#### ARCHAEOLOGICAL SEARCH

##### Historical Research

Mr. Watts and Miss Nicholson had gathered historical records from the National Archives, the Mariners Museum, Archives of the State of North Carolina, the Naval Academy, individuals who have researched Civil War ironclads and from other sources. Vital facts concerning U.S.S. MONITOR's design, construction and history emerged from this mass of information. Information of great concern in cruise planning and wreck identification was gleaned from these sources and from published material.

Of prime interest for the archaeological portion of the

expedition, was reconstruction of the track of U.S.S. RHODE ISLAND as she towed U.S.S. MONITOR south toward Beaufort during the last two days of December, 1862. Navigational fixes described in copies of the deck logs of U.S.S. RHODE ISLAND were plotted on an 1857 Coast Survey chart of Cape Hatteras. Similarly, fixes were plotted from the deck logs of U.S.S. PASSAIC and U.S.S. STATE OF GEORGIA. These vessels passed within five miles of RHODE ISLAND and MONITOR during the afternoon of December 30. Correspondence from Commander Bankhead of U.S.S. MONITOR and Admiral S. P. Lee, Atlantic Blockading Squadron Commander, added details concerning the possible site of MONITOR's sinking. These plots were transferred to a current Coast and Geodetic Survey (C&GS) chart 1109. Taking into account set and drift as determined from weather and sea state information plus the time elements from the historical records, it was possible to construct a rectangle representing the probable area of sinking. This became the primary search region. Another version described a "tear drop" pattern for the probable area of sinking. Both of these reconstructions proved to be amazingly accurate.

#### Search Techniques

The search for wreck of U.S.S. MONITOR commenced with great enthusiasm immediately following completion of the geological work, but it very rapidly became mired in technical problems. Buoys floated grandly for a period of minutes, then vanished beneath the sea, reception of the signals from the

transponders of the precision navigation system was inexplicably nil and the identification of sonar and magnetometer targets was more difficult than had been anticipated. One by one, the problems were resolved, or bypassed to provide a smoothly functioning search system.

During the first day of the expedition, the magnetometer had been "calibrated" by having the LCU steam toward and away from the magnetometer sensing head at various ranges. This provided a measure of signal height of the magnetic anomaly of a given mass at known ranges. This proved to be useful only in a general way, i.e., identifying a significant anomaly from the background fluctuations of the recorder.

The search plan called for simultaneously towing the side scan sonar fish, the magnetometer sensor and operating one or more vertical sonars in an overlapping pattern oriented parallel to the contours of the sea floor. When a promising target was sighted, the side scan sonar would be brought to bear in a tighter survey pattern to discern details of the contact for the purpose of evaluating size, shape and other identifying characteristics. If the side scan sonar continued to show a promising target on close examination, the location would be fixed by a series of passes plotted on a maneuvering board. At a convenience time, one or more buoys would be planted on or around the wreck as a visual aid to the deck officer, maneuvering on the bridge. He would, of course, be coned onto the site verbally by those observing sonar recorders in

the scientific electronics laboratory. Once on the wreck, the underwater photographic cameras and underwater television would be launched (always separately) to document the find.

In practice, this proved to be very difficult for several reasons. Often targets would appear on one system but not another, e.g., the magnetometer would show an apparent anomaly, but no contact of consequence would appear on the sonar recorder. A potentially promising target was occasionally lost after the first pass and relocated, only with the greatest difficulty. Often the target would be found to be a natural phenomenon rather than a shipwreck. However, once these limitations were recognized by those gaining some measure of sophistication from experiences while on watch, the planned search techniques developed into manageable methods. Improvisation became a necessity as each instrument in the search system broke down for brief (and sometimes seemingly long) periods of time. The watch chief was often called upon to exercise critical judgments concerning which bit of data was most significant, how best to use the available ship time--specifically, whether or not a target or a method was worth pursuing.

#### SEARCH RESULTS

A systematic search of the south and central section of the probable area of sinking revealed twenty-one sonar or magnetometer contacts. Only one of these seemed to be

promising on the basis of sonar records. It was located within eight miles of the position Commander Bankhead reported as the location of MONITOR's sinking in a depth of 300 feet. Three days and nights were consumed in the vicinity of this site as repeated lowerings of the photographic and television cameras were made, in an effort to identify the wreck. A semi-circular structure offered momentary encouragement, but the camera's eye eventually revealed the existence of hatches on deck, a gypsy head and details of construction which pointed conclusively to this wreck being a trawler. The realization did not come suddenly, but required the accumulation of vast amounts of data before positive identification was made.

Once the decision was made to abandon this site, a thoroughly dejected scientific party (and crew, who shared the enthusiasm for the search) again took up the laborious systematic search. This time, the search was centered in the northwest corner of the probably area of sinking, a sonar sweep was planned for the 200 and 230 feet contours (the magnetometer had failed, the towed cable disintegrating beyond hope of further use.

On August 27, while steaming northeast along the 200 feet contour, a long amorphous echo appeared on the side searching sonar. It moved across the recorder unrecognized; the signal offering an unintelligible streak to the watch stander. Fortunately, Mr. Fred Kelly who was Oceanographic Party Chief passed the recorder at the appropriate moment,

glanced up and recognized the potential significance of the echo. The watch chief, Dr. Sheridan, made the decision to change course to investigate the target. This chain of events and the action of reversing course proved to be of great consequence, probably being the most decisive moment of the voyage.

After the initial side scan sonar investigation of Wreck Site 2, a buoy was anchored in the vicinity and an intensive study was launched. Underwater photographs and television videotapes were made over a period lasting more than three days and nights. The first pass of the television camera revealed iron plates, a virtually flat unobstructed surface (the bottom of the hull), a thick waist (the armor belt) and a circular structure (the turret). Subsequent camera views added more details of 19th century construction and the description of smaller features. Dredging alongside the wreck yielded coal, clinkers and fragments of wood.

Evidence mounted with each successive television crossing, that the wreck was that of U.S.S. MONITOR, but the principal aim of the specialists was to determine whether or not the wreck was a vessel of another class. With this motivation, skeptical eyes focused on the television monitor and peered at sea floor negatives seeking clues that the ship was a barge or a capsized man-of-war with semi-circular gun tubs. These and other possibilities were eventually answered in the negative; the evidence after five months of intensive study points conclusively to this site as being the object of the search.

APPENDIX IV

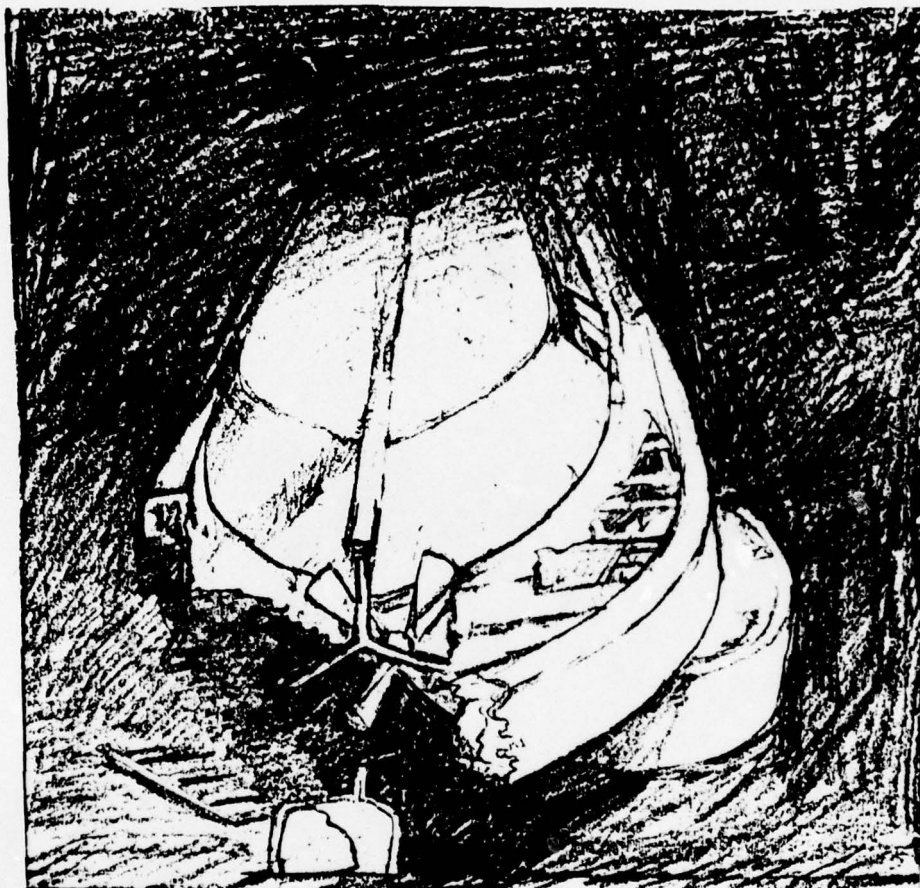


Figure 8. Artist's composite sketch from videotapes showing stern of capsized wreck at Site 2; the rudder is detached and resting on the sea floor.



Figure 9. Wreck Site 2, photograph of the armor belt taken by EG&G Model 204, 205 underwater camera. The camera and pinger are now resting inside the hull of the wreck!

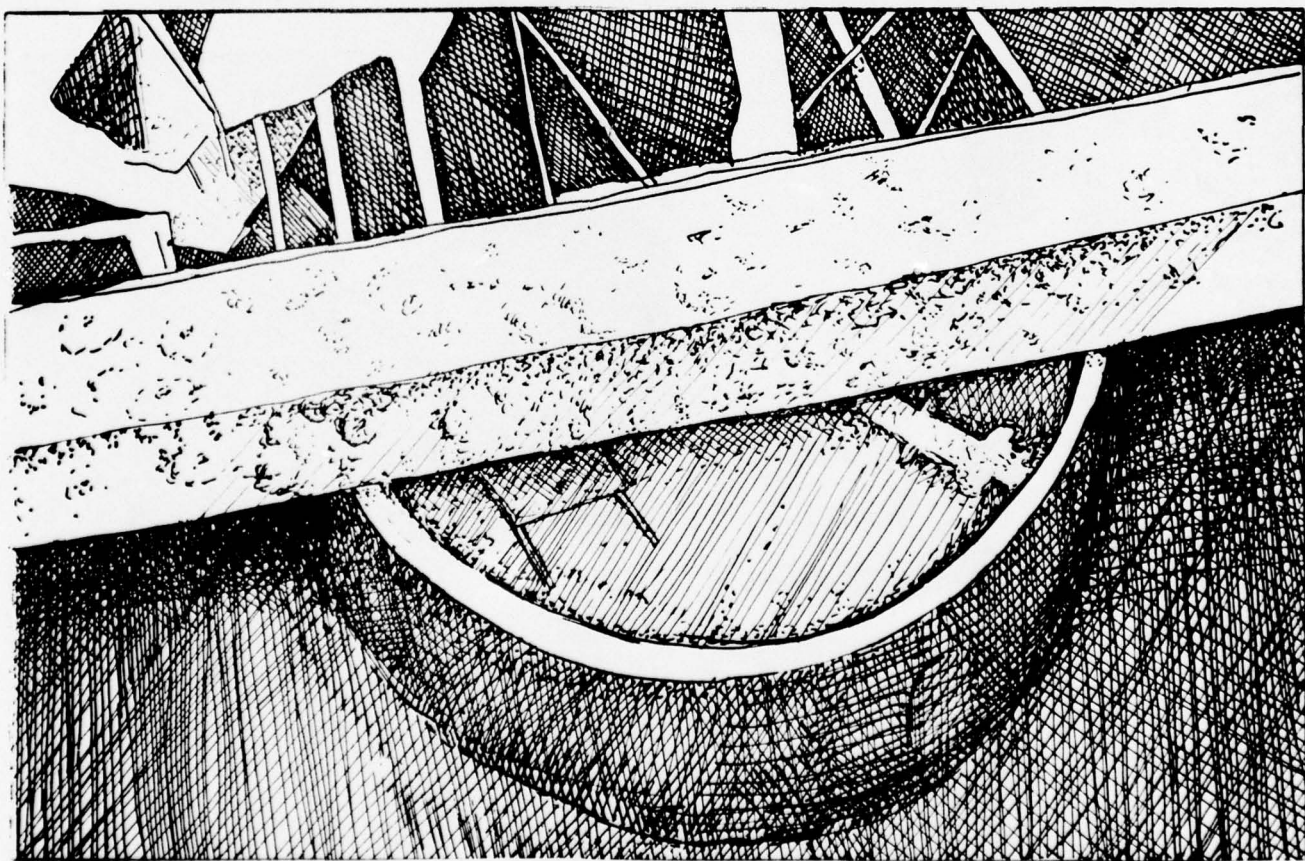
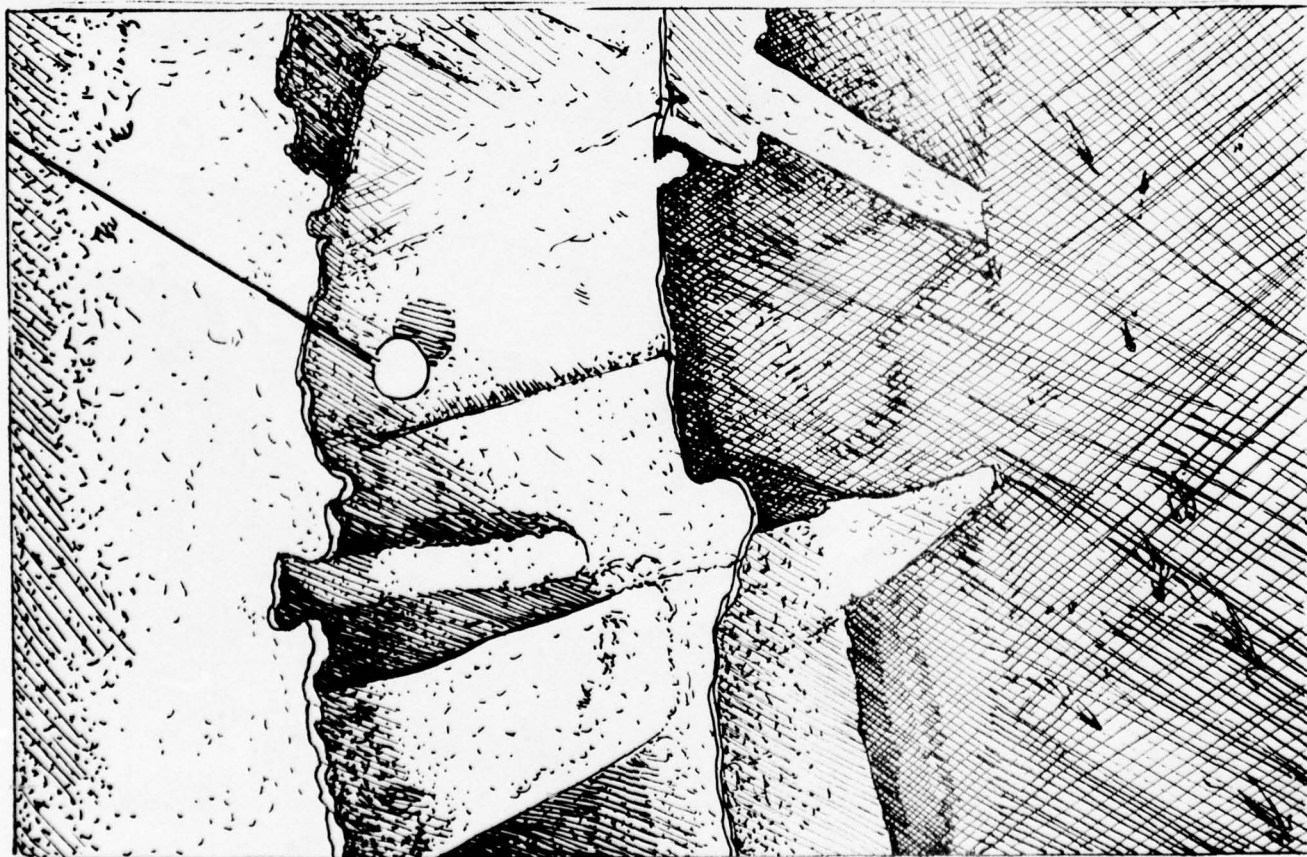


Figure 10. Wreck Site 2, photograph from videotapes of a portion of the turret (above) composite sketch of surrounding structures (below).



Figure 11. Photograph from videotapes of bilge and support stanchions to main deck (above), sketch of surrounding structures (below).





Duke University Research Vessel Eastward



Duke University Camera Being Lowered Over the Side



Photograph of Video Screen Showing Portion of Wreck  
Now Identified as Being the Turret.



Photograph of Video Screen Showing Stern Portion of Wreck.

EDITOR'S NOTE

When the 1974 academic year commenced at the U. S. Naval Academy, Miller commenced organizing Project Cheesebox, and submitted a research proposal to Professor Darden, which was forwarded to Dr. Mathieu, the Director of Research.

Gradually the project took shape and once started, proceeded to expand. Somewhere between being a 1/c midshipman, Company Commander, and a one man project, Miller found time to study for his normal courses. In the early months of the fall of 1973, Andahazy and Miller were found counciling in the library at the Academy (using the famous council light of the aborted May effort). Each encouraged the other, not wanting to let the other down.

Andahazy spent most of his time on the phone and at briefings trying to sell the project to the Navy community while Miller was busy digging in the National Archives and other depositories. Dr. Mathieu fully endorsed and supported the project arranging for a part time secretary and assigning an office with a phone. Soon, after a few breaths of life were breathed into it, the project started to breathe fire as Miller recruited from the Brigade several midshipmen who had a great deal to contribute. Gradually what started as a search became a complete documentary and engineering analysis of which this manuscript is a product.

PROJECT CHEESEBOX

A joint research project conducted under the auspices  
of the History Department at the United States Naval Academy.

9 September 1973

Project Personnel:

Dr. Richard Mathieu, Director of Research, USNA

Professor William M. Darden

Mr. William J. Andahazy

Ensign Michael Ellison, USN

Midn. 1/c Edward M. Miller

Midn. 1/c David Clites

Midn. 1/c Frederick Christensen

Midn. 1/c William Snook

Midn. 1/c Charles Richner

Midn. 1/c Herbert Hribar

Midn. 1/c John Meyer

Midn. 1/c Douglas Rau

### Purpose and Scope of Project Cheesebox

This project was originated with the sole purpose of coordinating modern scientific techniques with sound historical research; the objective being the documentation of the history of the ironclad USS Monitor and the investigation of the location of its hulk. It is hoped that the project manuscript will be a significant contribution to the field of historical research and that the results of the detailed magnetic survey and subsequent investigations of the Cape Hatteras area will assist in the charting and possible identification of the numerous wrecks.

It is proposed that this project consist of three phases. The first phase is the researching of the history of the ironclad and the development of a manuscript. The purpose of this phase is to gather all the available information concerning the conception, construction, and commissioned service of the vessel compiling a presentable manuscript which will be an authoritative and valuable asset to the student of Naval History and Architecture. This manuscript will be placed in the library at the United States Naval Academy.

Phase two will consist of the construction of two scale models. The first model will be a profile model with the ship rigged as she was on her fateful voyage to Beaufort, North Carolina. The second model will be an exploding model

with great care being given to the accuracy of detail. The second model will be built for two purposes. It will represent as far as practical the most accurate and most complete replica of the original warship. The innovations introduced with this vessel will be analyzed as a weapons system with attention given to the design of the engineering plant and the turret assembly. The completed model will be compared to the half model constructed by the engineer on board the USS Monitor. This model is located in the museum at the U.S. Naval Academy and the comparison to our model will be added to its documentation. Mr. Phillip Lundeberg of the Smithsonian Institution has expressed considerable interest in the results of this comparison.

Additional studies during this phase will include the construction and testing of a tow tank model to determine the ship's effectiveness as a weapons platform and to study the handling characteristics in different sea states. Both models will be placed in the collection at the Naval Academy Museum.

The third phase will be directed towards a detailed magnetic survey of the Cape Hatteras area. The theory and equipment that will be utilized is discussed in detail in Appendix I, a report compiled following the completion of a flight with VXN-8 Squadron's Project Magnet aircraft. Mr. William Andahazy, Naval Ship Research and Development Center, Annapolis, Maryland, is the Project Director in this phase and on the

basis of our results of our preliminary airborne survey, feels confident that given the opportunity to attempt a detailed surface survey of the area, his team will be able to locate the hulk of the USS Monitor if it is at all possible to distinguish it from the numerous other wrecks. It is important to note that Mr. Andahazy has at his disposal all of the equipment necessary and has permission from the proper authority for its use in this project. His equipment represents the "state of the art" in magnetic detection and a systematic survey of the area will represent the most modern and scientific attempt of the locating of the USS Monitor. Furthermore, the data gathered about the location of the other wrecks in the area will be very valuable to the Naval Oceanographic Office and the State of North Carolina.

A possible annex to this phase would be the retrieval of a piece of the hulk to aid in the positive identification of the ship and the determination of the feasibility of any further salvage. The third phase can only be undertaken with the support and assistance of the professional expertise found in the U.S. Navy as human safety and equipment safety are paramount. In addition, the magnitude of this project and its historical and scientific accuracy and reliability should discourage any novice attempts at locating and salvaging a hulk assumed to be the Monitor. The responsibility of the Navy in this area should not be overlooked.

Project Cheesebox Summary:

Phase I: Historical research with the objective of creating an authoritative fact file in manuscript form, deposited in the United States Naval Academy Library and other suitable locations.

Phase II: The construction and documentation of a highly accurate model with the appropriate studies in construction, engineering, stability, and handling characteristics to be included in the manuscript. In addition, a comparison of the project model with the U.S. Naval Academy model will be documented and deposited in the museum.

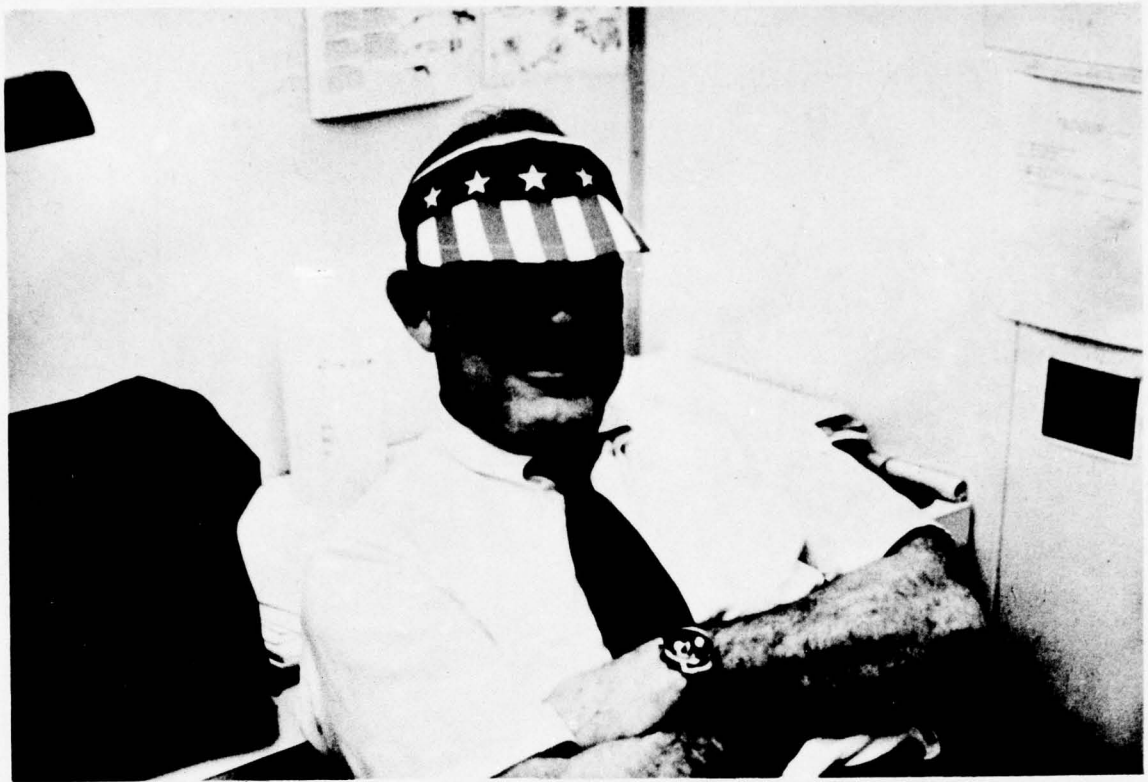
Phase III: A detailed surface survey of the primary search area determined from the historical research and previous airborne magnetic surveys. Any further investigation will be dependent upon the results of this survey. However, it is recommended that an underwater recovery capability be available for positive identification and determination of the feasibility of salvage. The results of this survey will also be included in the manuscript.

PROJECT CHEESEBOX MILESTONES

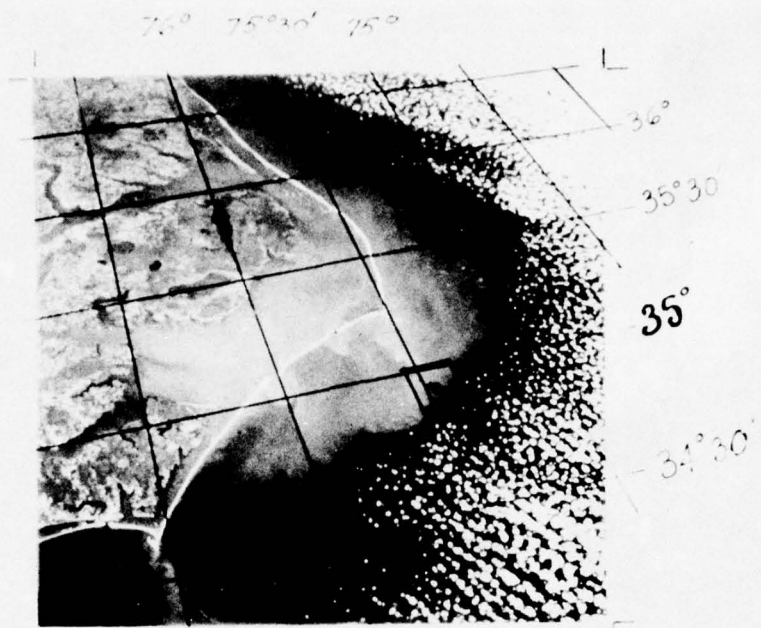
30 May 1973	Field trip to Cape Hatteras
17 July 1973	Airborne Magnetic Survey of search area A, North of lighthouse
28 July 1973	Meeting with Cdr. Robert Moss, Deputy Super- visor of Salvage
15 Aug. 1973	Meeting with Mr. E. A. Wardwell, Seaward, Inc. and Mr. Bell Grovesnor, National Geo- graphic
15 Oct. 1973	Meeting with Cdr. Don Walsh and Cdr. Jack McNish, Office of SecNav
17 Jan. 1974	Airborne Magnetic Survey of search area B
1 Feb. 1974	Meeting with Cdr. C. M. Jones, Navy Experi- mental Diving Unit
5 March 1974	Briefing - Capt. Geary, NRL
6 March 1974	Briefing - Mr. G. Carroll, Naval Oceano- graphic Office
11 March 1974	Round Table Meeting (Naval Research Laboratory)
1 April 1974	Surface Search, <u>Seaprobe</u>



Midshipmen Participants of Project Cheesebox and Captain  
E. W. Peterkin. (L to R, C. H. Richner, E. W. Peterkin,  
D. Rau, D. Clites, J. Meyer, W. Snook, F. H. Christensen).



Faculty Advisor to Project Cheesebox, Professor William M. Darden, History Department, U. S. Naval Academy.



CHEESEBOX MAGNETIC SURVEY  
17 JANUARY 1974 VXN-3

Apollo IX Space Photograph Showing Outer Banks of North Carolina and Rectangular Search Area of Project Cheesebox, 17 January 1974. Courtesy NASA and E. W. Peterkin



Interior of RP-3D Aircraft Used in Airborne Magnetic Survey  
Showing Scientific Area with Digital Readouts and Computerized  
Survey Equipment.

EDITOR'S NOTE

This next entry is the principle work of Midshipmen Herb Hribar and Doug Rau. They created an ocean engineering team which analyzed and tested the Monitor in the tow tank at the Naval Academy and also at the David Taylor Model Basin at Carderock, Maryland. Their study was entirely innovative and the cooperation between historians searching for historical data for the engineers who would test and analyze it under modern conditions became one of the significant hallmarks of Project Cheesebox.

Their conclusions are presented in an abridged format in the interests of conserving paper and the costs of printing. It is hoped that the original character of their work is still intact.

Their findings were significant. They predicted that the Monitor would invert upon sinking and that in all likelihood that the turret would not detach itself until the hull collided with the bottom. The film taken of the model in the same tow tank in which the new Trident submarines were being tested pointed out very dramatically the dire consequences of an ironclad at sea during a storm.

The model was constructed by Mr. Will Roloson at the Naval Academy. In addition, the assistance of Professor Paul Von Mater, Professor Roger Compton and Steve Enzinger are gratefully acknowledged.

### 1.0.0 ABSTRACT

The purpose of this phase of Project Cheesebox was to support the historical studies with an engineering analysis. This paper has been broken down into seven main areas of concentration.

- 1.0.0 Abstract
- 2.0.0 Summary
- 3.0.0 Model Construction and Ballasting
- 4.0.0 Model Scaling
- 5.0.0 Hydrostatic Calculations
- 6.0.0 Linear Wave Test
- 7.0.0 Towing Response
- 8.0.0 Structural Analysis
- 9.0.0 Proposed Sinking
- 10.0.0 Recommendations
- Appendix A
- Appendix B
- Appendix C
- Appendix D

Tests were conducted both at the U. S. Naval Academy Model Basin, Annapolis, Maryland and at Naval Ship Research and Development Center (NSRDC), Carderock, Maryland.

### 2.0.0 SUMMARY

Because of the large metacentric radius of the prototype,

the motions of the model were expected to be quite severe and its ability to ride open seas quite limited. However, the results of extensive model testing indicated that this was not the case.

2.1.1 The response of the vessel was found to be very dampened because of the large quantities of water taken on the deck after the bow was submerged. These results are both pictorially and graphically presented in this report.

2.1.2 Further, a very little slamming of the upper body was observed even in seas comparable to those in which the vessel sank.

2.1.3 Wave forces on the above deck structures, (turret, pilot house and smokestack) were observed to be excessive.

2.2.0 A structural analysis of the turret assembly indicated that it could support the weight of turret and associated structures if the vessel had overturned when it sank.

2.2.1 Since the turret is now displaced, it would seem to indicate that it was jarred loose from the vessel when the ocean bottom was reached.

2.2.2 A study of the supporting structures for the turret indicated that it did not provide any resistance to loads of the type which would be encountered if the vessel flipped.

2.2.2.1 If this were the case, the turret and the main body would have sank separately. Consequently they would not be as near each other as is presently believed.

### 3.0.0 MODEL CONSTRUCTION AND BALLASTING

3.1.0 The model of the USS Monitor was built by Mr. Will Roloson, U. S. Naval Academy. It was constructed of 4" x 4" sugar pine sections glued together with the grain of each plank running in a direction counter to that of the plank adjacent to it. This feature was included to prevent deformation. Also included in the model design to prevent deformation were four 1/8" x 1" x 12" stainless steel plates.

3.2.0 In order that ballasting weights could be positioned in the model, areas were routed out of the lower body forward and aft of the turret.

3.2.1 A lip was provided over the openings in order to insure that the acrylic hatch cover formed a water tight seal flush with the deck.

3.3.0 The model was constructed using a lines drawing obtained from the Mariners Museum in Newport News, Virginia. This drawing was found to be slightly deformed which caused the offsets, when laid out on the pattern, to delineate a slightly irregular curve. In order to compensate for these irregularities, the offsets were faired on the pattern before model construction commenced.

3.3.1 The model dimensions are:

- A. Overall length - 50"
- B. Maximum beam -14.5"
- C. Draft of lower body - 2.25"
- D. Draft of upper body - 1.75"

3.3.2 The scale factor in length for the model was 34.6.

3.4.0 All features of the prototype have been included in the model with the exception of the rudder, skeg propeller shaft and propeller. The contribution to the response resulting from these features was assumed to be insignificant. However, during the tests conducted at NSRDC, Carderock, it was necessary to attach a rudder fixed amidship to increase the towing stability of the vessel.

3.4.1 The towing chocks were positioned on the model corresponding to their position on the prototype. An aluminum plate was used to mount them in order to reduce the amount of modification to the model. Eyebolts were used rather than the actual towing chocks in order to simplify the towing operation.

3.4.2 Boundary layer trips were attached to both the upper and lower bodies four inches behind the forward perpendicular. The purpose of these trips was to insure that turbulent flow resulted past the hull.

3.4.3 A deck camber of 1/10" inch was maintained both fore and aft and athwart ships.

3.4.4 Three coats of DuPont Dulux enamel were applied to the model after it had been sanded and primed. The final coat was finished with rubbing compound.

3.4.5 It was estimated that 120 man-hours were expended on model construction.

#### 3.5.0 ACKNOWLEDGMENTS

Special thanks is extended to the following people for the vital roles they played in the completion of this project.

Professors Paul Von Mater and Roger Compton for their continuous help in Naval Architecture and Design.

Mr. Chuck Seiber, NSRDC, Carderock, Maryland, for his invaluable assistance in conducting the model tests at NSRDC.

Mr. Will Roloson for his construction of the model.

Mr. Ebbert Bosworth and Mr. Steve Enzinger for their assistance in conducting the model tests at the Naval Academy Model Basin.

#### 3.6.0 MODEL BALLASTING

In order to insure that meaningful results would be obtained from the model tests, it was necessary to ballast the model similarly to the prototype. It was particularly necessary to effect a similarity between prototype and model displacement, center of gravity and gyradius.

3.6.1 Procedure: In order to ballast the model, the freeboards, fore and aft, of the prototype were determined from the lines drawing freeboard gauges were then set to correspond to these distances and attached to the vessel. Ballasting weight was added so that the desired displacement was achieved with a level trim. The ballasting weights minus 1% (forward - 16.49 pounds; aft - 13.76 pounds) were cast to fit as far forward and aft as possible.

3.6.2 The unballasted model, including the tare block, was swung from a knife edge attached to the bow in order to determine the gyradius. The results are presented below:

	Trial 1	Trial 2
Time for 50 swings	95.0 secs	94.9 secs
Time for 100 swings	189.9 secs	

$$T_0 = 189.9/100 = 1.9 \text{ secs/period}$$

3.6.3 The static angle of deflection was determined to be  $5^\circ$  the distance between the center of gravity of the unballasted model (measured using the balance shown below) and the knife edge was measured at 28  $\frac{5}{8}$ ". The distance  $X_0$  was then calculated:

$$X_0 = \frac{X}{\cos \theta} = 29.37 \text{ inches}$$

Using the above data, the gyradius of the unballasted model was determined to be 14.07 inches from

$$k_u = 9.78 T_0^2 X_0 - X_0^2 \text{ (inches)} \quad \dots (1)$$

3.6.4 The ballasting weights were positioned in the vessel as far forward and aft as possible still maintaining the desired center of gravity. The vessel was then floated to a level form using the trimming weights. Again the model was swinging with the following results:

	Trial 1	Trial 2
Time for 50 swings	94.2 secs	94.1 secs
Time for 100 swings	188.3 secs	
Period	1.88 seconds/ period	

3.6.5 Since the same physical arrangement was maintained X remained 28 5/8". The static angle of deflection was measured to be 5°. As before,  $X_0$  was found to be 29.37 inches. From the above data and using formula (1), the ballasted gyradius was determined to be 12.35 inches.

3.6.6 Discussion. For modern hull forms, the ballasted gyradius should equal 25% of the length between perpendicular. The ballasted gyradius of the Monitor model was 21% of the length between perpendiculars. This distance was fixed because of the physical structure of the model. However, because of the unusual design of this vessel, there is no way to determine the actual gyradius of the prototype. Therefore, a gyradius of 21% of the distance between perpendiculars may be as valid as one which is 25% of the ship's overall length.

#### 4.0.0 MODEL SCALING

4.1.0 The purpose of this project was to measure the response of the vessel in waves, consequently the gravitational effects on the water surface were of prime importance. In order to examine the response of the prototype using a model these effects must be considered. Therefore, Froude scaling, which was developed for this purpose, was the best method.

4.1.1 Froude scaling is based on the relationship of model to prototype given by:

$$\frac{V_p}{L_{pgp}} = \frac{V_m}{L_{mgm}}$$

where

$V_p$  = velocity of prototype

$V_m$  = velocity of model

$L_p$  = characteristic length of prototype

$L_m$  = characteristic length of model

$g_m \quad g_p$  = force of gravity (Olson, pg. 147)

From this basic relation can be derived the following ratios:

$$\begin{aligned} \frac{L_m}{L_p} &= \frac{H_m}{H_p} \\ \frac{V_m}{V_p} &= \frac{L_m}{L_p} \\ \frac{t_m}{t_p} &= \frac{L_m}{L_p} \end{aligned} \quad \frac{1}{2}$$

$$\frac{F_m}{F_p} = \frac{L_m}{L_p}$$

where

subscript m denotes model

subscript p denotes prototype

H = wave height

t = time

F = Force (Olson, page 150)

4.1.2 Using these relationships the various responses of the prototype could be determined by observing the responses of the model and employing the appropriate scale factor.

4.1.3 Since

$$L_m = 5.0'$$

$$L_p = 173.0'$$

$$\text{the scale factor } \frac{L_p}{L_m} = \frac{173.0}{5.0} = 34.6$$

#### 5.0.0 HYDROSTATIC CALCULATIONS

5.1.0 Background. One of the best ways to express a ship's characteristics is to develop a curve depicting its hydrostatic parameters. Since no such curve was available for the Monitor, it was necessary to calculate and plot these parameters.

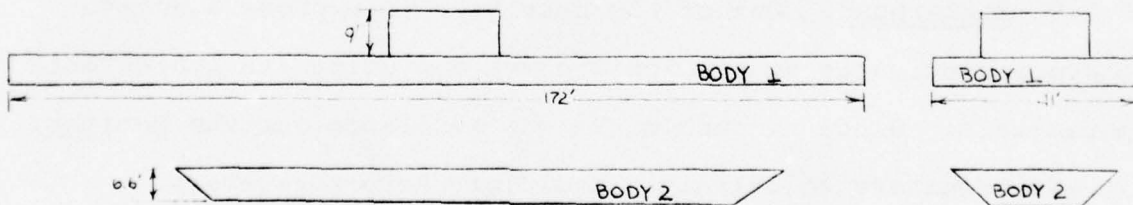
5.2.0 Procedure. The computer program, "HYDSTA," developed by Professor Roger Compton, U. S. Naval Academy, was used to

compute the hydrostatic parameters of the Monitor. The inputs to this program were:

- A. Length between perpendiculars.
- B. Maximum beam at design waterline.
- C. Form of offsets.
- D. Number of stations.
- E. Number of half-stations.
- F. Number of waterplanes.
- G. Basic waterplane spacing.
- H. Table of offsets.

5.2.1 The table of offsets was developed from the lines drawing of the USS Monitor by measuring the half-breadth of the model for each station on several waterplanes. The waterplane spacing (distance between waterplanes was chosen so that the integrations of the entire body would result in an accurate calculation. These integrations were carried out utilizing Simpson's rules of numerical integration.

5.2.2 It should be noted that because the Monitor hull form is so irregular, it was separated into two separate forms to facilitate hydrostatic calculations.



After the calculations for the separate bodies were completed, the parameters were combined in order to obtain the parameters for the entire ship.

5.3.0 Data. The following parameters were calculated:

- A. Displacement volume (feet<sup>3</sup>).
- B. Displacement in salt water (long tons).
- C. Displacement in fresh water (long tons).
- D. Vertical position of the center of buoyancy (feet above the baseline).
- E. Longitudinal position of the center of buoyancy (feet forward or aft of amidships).
- F. Waterplane area (feet<sup>2</sup>).
- G. Longitudinal position of the center of buoyancy (feet forward or aft of amidships).
- H. Longitudinal position of the center of flotation (feet forward or aft of amidships).
- I. Tons per inch immersion (tons/inch).
- J. Longitudinal metacentric radius (feet).
- K. Transverse metacentric radius (feet).
- L. Moment to change trim one inch

$$\frac{\text{foot} - \text{tons}}{\text{inch}}$$

- M. Block coefficient.
- N. Prismatic coefficient.
- O. Midship section coefficient.
- P. Waterplane coefficient.
- Q. Vertical prismatic coefficient.
- R. Displacement - length ratio.
- S. Beam - draft ratio.
- T. Length - draft ratio.
- U. Table of offsets.
- V. Sectional area curve.

The tabuloid values and a graph of several of the important hydrostatic parameters and the sectional area curve are presented on the following pages.

5.4.0 Discussion of Results. The reader should note the discontinuity which occurs at the 6.5 foot waterline. This

resulted from the large discontinuity in the hull form where the upper and lower bodies joined. Also, it should be noted that many of the parameters for the upper body remain constant regardless of draft due to constant waterplane area.

5.4.1 The sectional areas computed by "HYDSTA" were not utilized to plot the total sectional area curve. "HYDSTA" assumes at least a second order curve and integrates over such a curve. A close examination of the Monitor hull reveals that it is composed of several linear geometric figures. In order to achieve a more accurate calculation of sectional area, the program "Section" was written which was designed to compute sectional areas for a body such as the Monitor.

5.4.2 Because accurate information was not available concerning the weight distribution in the Monitor the center of gravity could not be calculated. However, a program which would compute the center of gravity was written in the event that this information could be obtained.

Table of Offsets as Input into "HYDSTA" for Monitor Lower Body

Waterplane Heights Above Baseline

<u>Sta.</u> <u>No.</u>	<u>0 Ft.</u>	<u>3.25 Ft.</u>	<u>6.5 Ft.</u>
0	0	0	0
1	0	0	3.39
2	0	0.63	6.61
3	0	3.25	8.66
4	1.03	5.81	10.63
5	3.26	7.94	12.41
6	5.18	9.69	13.84
7	6.61	10.88	14.96
8	7.72	11.81	15.8
9	8.35	12.44	16.43
10	8.75	12.75	16.74
11	9.02	13	16.96
12	9.02	13	16.96
13	9.02	13	16.96
14	9.02	13	16.96
15	9.02	13	16.96
16	9.02	13	16.96
17	9.02	13	16.96
18	9.02	13	16.96
19	9.02	13	16.96
20	9.02	13	16.96
21	9.02	13	16.96
22	9.02	13	16.96
23	9.02	13	16.96
24	9.02	13	16.96
25	9.02	13	16.96
26	9.02	13	16.96
27	9.02	13	16.96
28	9.02	13	16.96
29	9.02	13	16.96
30	9.02	13	16.96
31	9.02	12.94	16.96
32	8.71	12.81	16.96
33	8.21	12.38	16.74
34	7.41	11.94	16.43
35	6.21	11.06	15.85
36	4.73	9.88	14.87
37	2.63	8.06	13.48
38	0.22	5.81	11.52
39	0	2.69	9.02
40	0	0	5.76
41	0	0	0

Sectional Areas as Computed by "HYDSTA" For Monitor Lower Body

<u>Sta.</u> <u>No.</u>	<u>0 Ft.</u>	<u>3.25 Ft.</u>	<u>6.5 Ft.</u>
0	0	0	0
1	0	-1.84	7.34
2	0	-0.85	19.78
3	0	9.39	46.93
4	0	22.21	75.62
5	0	36.51	102.77
6	0	48.52	125.19
7	0	56.95	141.03
8	0	63.53	153.31
9	0	67.62	161.5
10	0	69.88	165.73
11	0	71.58	168.96
12	0	71.58	168.96
13	0	71.58	168.96
14	0	71.58	168.96
15	0	71.58	168.96
16	0	71.58	168.96
17	0	71.58	168.96
18	0	71.58	168.96
19	0	71.58	168.96
20	0	71.58	168.96
21	0	71.58	168.96
22	0	71.58	168.96
23	0	71.58	168.96
24	0	71.58	168.96
25	0	71.58	168.96
26	0	71.58	168.96
27	0	71.58	168.96
28	0	71.58	168.96
29	0	71.58	168.96
30	0	71.58	168.96
31	0	71.32	168.44
32	0	69.91	166.64
33	0	66.81	161.35
34	0	62.91	155.13
35	0	56.16	143.65
36	0	47.57	128.09
37	0	34.75	104.76
38	0	19.53	75.79
39	0	6.77	42.86
40	0	-3.12	12.48
41	0	0	0

Hydrostatic Variables for Monitor  
Lower Body as computed by "HYDSTA"

LPP	=	124 Feet
B (MLD)	=	34 Feet
T (MLD) (TO DWL)	=	5 Feet
L/B	=	3.64706
B/T (DWL)	=	6.8
L/T (DWL)	=	24.8

Hydrostatic Calculations for the 0 Foot Waterplane

Waterplane Area = 1624.82 Square Feet

Longitudinal location of the center of flotation  
is 1.06401 Feet aft of amidships.

Longitudinal area moment of inertia about the center  
of flotation is 1.14257 E+6 Quartic Feet.

Transverse area moment of inertia about the center of  
flotation is 39466.1 Quartic Feet.

Tons per inch immersion = 3.86863 Tons per Inch  
in salt water.

Approximate moment to alter trim one inch  
= 21.9388 Foot-Tons per Inch  
of trim in salt water.

Correction to displacement per Foot of trim by the  
stern is 0.398348 Tons per Foot.  
of trim in salt water.

Waterplane Coefficient 0.385395

Hydrostatic Calculations for the 3.25 Foot Waterplane

Waterplane Area = 2556.92 Square Feet

Longitudinal location of the center of flotation  
is 1.38464 Feet aft of amidships.

Longitudinal area moment of inertia about the center  
of flotation is 2.15753 E+6 Quartic Feet.

Transverse area moment of inertia about the center  
of flotation is 127851. Quartic Feet.

Tons per Inch immersion = 6.08769 Tons per Inch  
in salt water.

Approximate moment to alter trim one Inch  
= 41.4272 Foot-Tons per Inch  
of trim in salt water.

Correction to displacement per Foot of trim by the  
stern is 0.815762 Tons per Foot  
of trim in salt water.

<u>Quantity &amp; Units</u>	<u>By Vertical Integration</u>	<u>By Longitudinal Integration</u>
Volume of displacement in Cubic Feet	6762.24	6762.24
Molded displacement in salt water in long Tons	193.207	193.207
Height of the center of buoyancy above the baseline in Feet	1.72247	1.72247
Longitudinal location of the center of buoyancy is Feet aft of amidships	1.26019	1.26019
Transverse metacentric radius in Feet	18.9065	18.9065
Longitudinal metacentric radius in Feet	319.055	319.055
Block coefficient	0.493522	0.493522
Prismatic coefficient	0.761908	0.761908
Midship section coefficient		0.647745
Waterplane coefficient		0.606479
Vertical prismatic coefficient	0.81375	0.81375
Displacement-length ratio	101.335	101.335
Volumetric coefficient	3.54671 E-3	3.54671 E-3
Beam-draft ratio		10.4615
Length-draft ratio		38.1538

Hydrostatic Calculations for the 6.5 Foot Waterplane

Waterplane area = 3611.17 Square Feet

Longitudinal location of the center of flotation  
is 1.52376 Feet aft of amidships.

Longitudinal area moment of inertia about the center  
of flotation is 3.58163 E+6 Quartic Feet.

Transverse area moment of inertia about the center  
of flotation is 306053. Quartic Feet.

Tons per Inch immersion = 8.59803 Tons per Inch  
in salt water.

Approximate moment to alter trim one Inch  
= 68.7716 Foot-Tons per Inch  
of trim in salt water.

Correction to displacement per Foot of trim by the  
stern is 1.26787 Tons per Foot.  
of trim in salt water.

<u>Quantity &amp; Units</u>	<u>By Vertical Integration</u>	<u>By Longitudinal Integration</u>
Volume of displacement in Cubic Feet	16752.3	16752.3
Molded displacement in salt water in long Tons	478.637	478.637
Height of the center of buoyancy above the baseline in Feet	3.66747	3.66747
Longitudinal location of the center of buoyancy is Feet aft of amidships	1.38344	1.38344
Transverse metacentric radius in Feet	18.2693	18.2693
Longitudinal metacentric radius in Feet	213.799	213.799
Block coefficient	0.611308	0.611308
Prismatic coefficient	0.799608	0.799608
Midship section coefficient		0.76451

<u>Quantity &amp; Units</u>	<u>By Vertical Integration</u>	<u>By Longitudinal Integration</u>
Waterplane coefficient		0.85654
Vertical prismatic coefficient	0.713695	0.713695
Displacement-length ratio	251.039	251.039
Volumetric coefficient	8.67637 E-3	8.78637 E-3
Beam-draft ratio		5.23077
Length-draft ratio		19.0769

Sectional Area as Computed by "HYDSTA" for Monitor Upper Body

Table of Sectional Areas in Square Feet

Waterplane Heights Above Baseline

<u>Sta.</u> <u>No.</u>	<u>0 Ft.</u>	<u>1.25 Ft.</u>	<u>2.5 Ft.</u>	<u>3.75 Ft.</u>
0	0	0	0	0
1	0	18.63	37.25	55.88
2	0	39.05	78.1	117.15
3	0	43.4	86.8	130.2
4	0	48.65	97.3	145.95
5	0	51.55	103.1	154.65
6	0	51.9	103.8	155.7
7	0	51.9	103.8	155.7
8	0	51.9	103.8	155.7
9	0	51.9	103.8	155.7
10	0	51.9	103.8	155.7
11	0	51.9	103.8	155.7
12	0	51.9	103.8	155.7
13	0	51.9	103.8	155.7
14	0	51.9	103.8	155.7
15	0	51.35	102.7	154.05
16	0	48.32	96.65	144.97
17	0	42.07	84.15	126.22
18	0	41.4	82.8	124.2
19	0	18.4	36.8	55.2
20	0	0	0	0

Hydrostatic Variables for Monitor as Computed  
by "HYDSTA" for Monitor Upper Body

LPP	=	173 Feet
B (MLD)	=	41.5 Feet
T (MLD) (TO DWL)	=	3.75 Feet
L/B	=	4.16867
B/T (DWL)	=	11.0667
L/T (DWL)	=	46.1333

Hydrostatic Calculations for the 0 Foot Waterplane

Waterplane area = 6010.83 Square Feet

Longitudinal location of the center of flotation  
is 5.14515 E-2 Feet forward of amidships.

Longitudinal area moment of inertia about the center  
of flotation is 1.11533 E+7 Quartic Feet.

Transverse area moment of inertia about the center  
of flotation is 752529 Quartic Feet.

Tons per Inch immersion = 14.3115 Tons per Inch  
in salt water.

Approximate moment to alter trim one Inch  
= 153.5 Foot-Tons per Inch  
of trim in salt water.

Correction to displacement per Foot of trim by the  
stern is -5.10761 E-2 Tons per Foot  
of trim in salt water.

Waterplane coefficient 0.837221

Hydrostatic Calculations for the 1.25 Foot Waterplane

Waterplane area = 6010.83 Square Feet

Longitudinal location of the center of flotation  
is 5.14515 E-2 Feet forward of amidships.

Longitudinal area moment of inertia about the center  
of flotation is 1.11533 E+7 Quartic Feet.

Transverse area moment of inertia about the center  
of flotation is 752529 Quartic Feet.

Tons per Inch immersion = 14.3115 Tons per Inch  
in salt water.

Approximate moment to alter trim one Inch  
= 153.5 Foot-Tons per Inch  
of trim in salt water.

Correction to displacement per foot of trim by the  
stern is  $-5.10761 \text{ E-2}$  Tons per Foot  
of trim in salt water.

<u>Quantity &amp; Units</u>	<u>By Vertical Integration</u>	<u>By Longitudinal Integration</u>
Volume of displacement in Cubic Feet	7513.53	7513.53
Molded displacement in salt water in long Tons	214.672	214.672
Height of the center of buoyancy above the baseline in Feet	0.625	0.625
Longitudinal location of the center of buoyancy is Feet forward of amidships	5.14515 E-2	5.14516 E-2
Transverse metacentric radius in Feet	100.156	100.156
Longitudinal metacentric radius in Feet	1484.43	1484.43
Block coefficient	0.837221	0.837221
Prismatic coefficient	0.836818	0.836818
Midship section coefficient		1.00048
Waterplane coefficient		0.837221
Vertical prismatic coefficient	1.	1
Displacement-length ratio	41.4608	41.4608
Volumetric coefficient	1.45113 E-3	1.45113 E-3
Beam-draft ratio		33.2
Length-draft ratio		138.4

Hydrostatic Calculations for the 2.5 Foot Waterplane

Waterplane area = 6010.83 Square Feet

Longitudinal location of the center of flotation  
is 5.14515 E-2 Feet forward of amidships.

Longitudinal area moment of inertia about the center  
of flotation is 1.11533 E+7 Quartic Feet.

Transverse area moment of inertia about the center  
of flotation is 752529 Quartic Feet.

Tons per Inch immersion = 14.3115 Tons per Inch  
in salt water.

Approximate moment to alter trim one Inch  
= 153.5 Foot-Tons per Inch  
of trim in salt water.

Correction to displacement per Foot of trim by the  
stern is -5.10761 E-2 Tons per Foot  
of trim in salt water.

<u>Quantity &amp; Units</u>	<u>By Vertical Integration</u>	<u>By Longitudinal Integration</u>
Volume of displacement in Cubic Feet	15027.1	15027.1
Molded displacement in salt water in long Tons	429.345	429.345
Height of the center of buoyancy above the baseline in Feet	1.25	1.25
Longitudinal location of the center of buoyancy is Feet forward of amidships	5.14515 E-2	5.14516 E-2
Transverse metacentric radius in Feet	50.0782	50.0782
Longitudinal metacentric radius in Feet	742.214	742.214
Block coefficient	0.837221	0.837221
Prismatic coefficient	0.836818	0.836818
Midship section coefficient		1.00048

<u>Quantity &amp; Units</u>	<u>By Vertical Integration</u>	<u>By Longitudinal Integration</u>
Waterplane coefficient		0.837221
Vertical prismatic coefficient	1.	1
Displacement-length ratio	82.9216	82.9216
Volumetric coefficient	2.90226 E-3	2.90226 E-3
Beam-draft ratio		16.6
Length-draft ratio		69.2

Hydrostatic Calculations for the 3.75 Foot Waterplane

Waterplane area = 6010.83 Square Feet

Longitudinal location of the center of flotation  
is 5.14515 E-2 Feet forward of amidships.

Longitudinal area moment of inertia about the center  
of flotation is 1.11533 E+7 Quartic Feet.

Transverse area moment of inertia about the center  
of flotation is 752529 Quartic Feet.

Tons per Inch immersion = 14.3115 Tons per Inch  
in salt water.

Approximate moment to alter trim one Inch  
= 153.5 Foot-Tons per Inch  
of trim in salt water.

Correction to displacement per Foot of trim by the  
stern is -5.10761 E-2 Tons per Foot  
of trim in salt water.

<u>Quantity &amp; Units</u>	<u>By Vertical Integration</u>	<u>By Longitudinal Integration</u>
Volume of displacement in Cubic Feet	22540.6	22540.6
Molded displacement in salt water in long Tons	644.017	644.017
Height of the center of buoyancy above the baseline in Feet	1.875	1.875

<u>Quantity &amp; Units</u>	<u>By Vertical Integration</u>	<u>By Longitudinal Integration</u>
Longitudinal location of the center of buoyancy is Feet forward of amidships	5.14515 E-2	5.14516 E-2
Transverse metacentric radius in Feet	33.3855	33.3855
Longitudinal metacentric radius in Feet	494.809	494.809
Block coefficient	0.837221	0.837221
Prismatic coefficient	0.836818	0.836818
Midship section coefficient	1.00048	
Waterplane coefficient	0.837221	
Vertical prismatic coefficient	1	1
Displacement-length ratio	124.382	124.382
Volumetric coefficient	4.35339 E-3	4.35339 E-3
Beam-draft ratio	11.0667	
Length-draft ratio	46.1333	

Hydrostatic Parameters as Computed  
by "HYDSTA" for USS Monitor entire Hull Form

<u>Draft</u>	<u>Displacement Volume</u> (ft <sup>3</sup> )	<u>Displacement in Salt Water</u> (Long Tons)	<u>Displacement in Fresh Water</u> (Long Tons)
0	0(x10 <sup>03</sup> )	0 (x10 <sup>1</sup> )	0 (x10 <sup>1</sup> )
3.25'	6762.24	193.21	187.84
6.5'	16,752.3	478.637	465.34
9.0'	31,779.4	907.983	882.76
11.5'	46,806.4	1337.32	1300.18

<u>Draft</u>	<u>Vertical Position of Center of Buoyance</u> (ft above heel)	<u>Longitudinal Position of Center of Buoyance</u>		<u>Area of Water Planes</u> (ft <sup>2</sup> )
		(-)	(+)	
0	0	0 (x10 <sup>-1</sup> )		1624.82 (x10 <sup>2</sup> )
3.25	1.72	-1.26		2556.92
6.5	3.67	-1.38		3611.17 discontinuity (6010.83)
9.0	5.60	+4.59		6010.83
11.5	7.09	+.4.60'		6010.83

Longitudinal Position of Center of Gravity

(Ft. aft of the Forward Perpendicular)

86.50'  
87.76'  
87.88'  
81.91'  
81.90'  
807

<u>Draft</u>	<u>Longitudinal Center of Flotation</u> - + (ft.aft.or fwd. of amidships)	<u>Tons per Inch Immersion</u> (Tons)	<u>Longitudinal Metrecentric Radius</u> (Ft.)	<u>Transverse Metacentric Radius</u> (Ft.)
6.5	+5.14 X10 <sup>-2</sup>	14.31	665.78	44.92
9.0	+5.14 X10 <sup>-2</sup>	14.31	351.00	23.68
11.5	+5.14 X10 <sup>-2</sup>	14.31	238.28	16.08

<u>Draft</u>	<u>Moment to Change Trim 1 Inch</u> ( <u>Ft-Tons</u> / <u>Inch</u> )	<u>BM = <math>\frac{I}{V}</math></u> (ft)	<u>KM</u>
0	21.94	0	-
3.25	41.43	318.98	320.7
6.5	68.77/153.5	213.70/665.1	217.37/669.3
9.0	153.5	350.85	356.45
11.5	153.5	238.22	245.31

#### 6.0.0 LINEAR WAVE TESTS

6.1.0 Background. There have been many theories proposed about the response of the Monitor in various sea states. Many expressed their belief that she was one of the easiest riding ships in the fleet. Others believed that the vessel was simply the whim of an eccentric inventor.

6.2.0 Purpose. The purpose of this phase of the study was to examine the response of the scale model of the Monitor to various linear wave conditions.

6.3.0 Theory. Since the Monitor was in equilibrium it exhibited the tendency to right itself when it was disturbed on a seaway. There are two forces which determine the equilibrium of any ship.

- A. gravity
- B. buoyancy

The force of gravity acts downward at a position which is the resultant of all of the downward forces acting on the ship. The force of buoyancy acts upward at a position which is the resultant of all buoyant forces acting on the ship. For a vessel to be stable, these two forces must be in vertical alignment.

6.3.1 Upon displacing a vessel, the shape of the underwater body changes. Consequently the position of the center of buoyancy changes, and the center of gravity and buoyancy are no longer in vertical alignment.

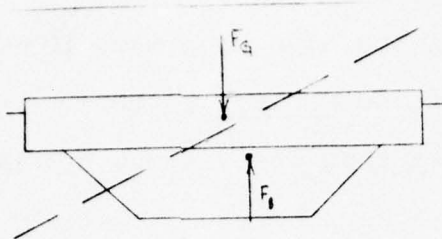


FIGURE 8

A vessel in a stable condition will develop a moment which tends to right the vessel. The magnitude of the developed moment gives an indication of the quickness with which the vessel will be righted. In other words, the magnitude of this moment determines the severity of the response of the vessel.

6.3.2 A measure of this response is the metacentric height  $\overline{BM}$  which is calculated using:

$$\overline{BM} = \frac{I}{V}$$

where  $I$  = waterplane moment of inertia

$V$  = underwater volume of hull (Gilmer, page 124)

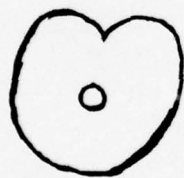
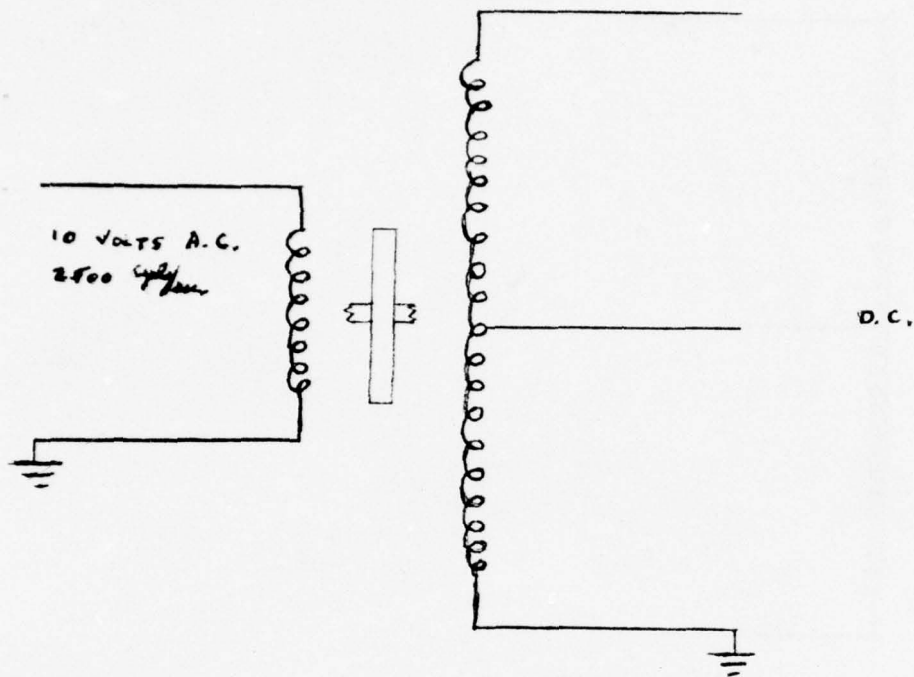
Using the parameters as calculated in using "HYDSTA," the  $\overline{BM}$  for the Monitor is 350.85 ft.

6.3.3 This is a relatively large value which indicates that this vessel should have a very rapid response making the vessel very uncomfortable to ride.

#### 6.4.0 Apparatus

6.4.1 In the Naval Academy Model Basin the parameters

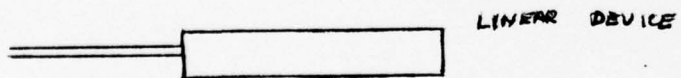
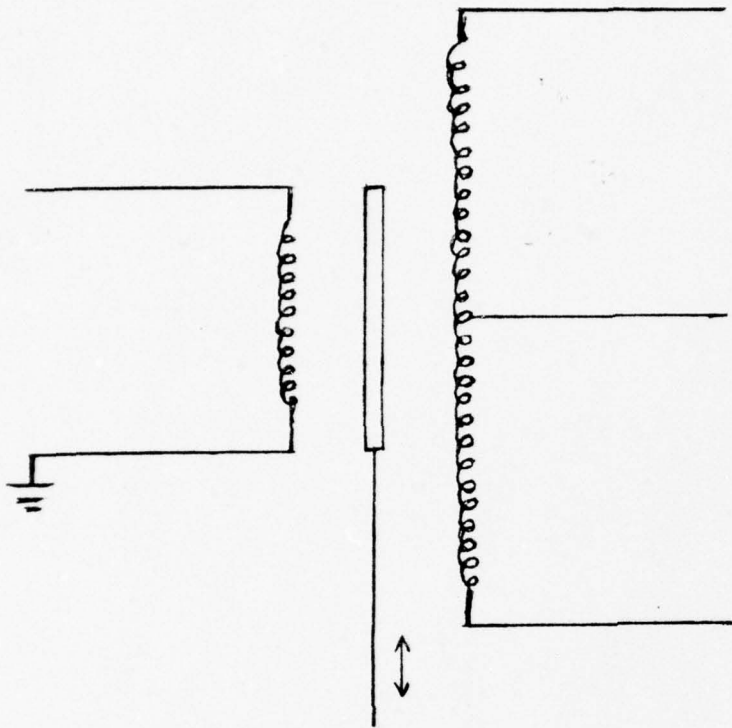
# ROTARY VARIABLE DIFFERENTIAL TRANSFORMER



ROTOR

<u>OUT PUT VOLTAGE</u>	
10° - .252	-10° - .250
20° - .501	-20° - .502
30° - .752	-30° - .758
40° - .998	-40° - 1.000

SANBORN LINEARSYN DIFFERENTIAL  
TRANSFORMER  
585 DT - 050



of pitch and heave were measured. Pitch is the angular rotation of the longitudinal axis about a transverse axis passing through the center of gravity; heave, the vertical movement of the longitudinal horizontal plane.

6.4.2 These two parameters are sensed and measured by means of two rotary variable differential transformers. They are excited by a 10 volt A.C. current with a frequency of 2500 cycles per second. This coupled with the movement of the rotor caused by the movement of the force block attached to the model induces a current in the secondary coils where the A.C. is rectified to D.C. current. This current is sent to a small patch panel on the carriage assembly where it is linked to the Gould Brush Recorder (USNA No. 2327-3072). The output voltage is a function of the amount of rotation of the rotor.

6.4.3 Translational movement of the model is sensed and measured by a Sanborn linearsyn differential transformer model number 585DT-050. It is excited by the same 10 volt A.C. 2500 cycle per second current as the rotary transformers. The linear movement of a bar induces a current in the secondary coil which is rectified to a D.C. current. The magnitude of the output voltage is a function of the linear position of the bar. At a rate of .00475 MU per inch, the D.C. current is transmitted to the same patch panel on the carriage assembly where it too is sent to the Gould Brush Recorder.

6.4.4 The waves of the U. S. Naval Academy Model Basin are created by a pressure-vacuum action. The wave generating area is isolated in a half cylinder arrangement. There are four pipes leading into the cylinder which carry the pressure and vacuum (2 each). A small electric motor turns a shaft which is connected to a cam. This cam alternately opens two flapper valves. Two pumps, one producing pressure the other vacuum are regulated by the flapper valves. The waves are then generated by an alternating high and low pressure area within the half-cylinder corresponding to the trough and crest of the wave. The frequency of the waves may be changed by varying the speed of the motor which operates the flapper valves. The wave heights may be changed by varying the intensity of the high and low pressures, with the associated motor.

6.4.5 The wire wave gauges used to measure wave height consisted of two parallel wires separated by a small distance. These wires are connected to a wheatstone bridge which measures the resistance between them. As the waves pass, the resistance in the wires decreases (crest) or increases (trough). These varying resistances then are used to generate a voltage which is recorded on the strip chart recorder.

6.5.0 Calibration. All calibrations were done in essentially the same manner. The measuring device was displaced by standard

distance which caused a corresponding displacement of the stylus of the strip chart recorder. This displacement was marked and the entire procedure repeated several times. The distances were then marked in their respective units on a calibration board which was used to break the data.

6.6.0 Procedure. Tests were run in the U. S. Naval Academy Model Basin. The model was dynamically ballasted so that its longitudinal response would be an accurate representation of that of the prototype.

6.6.1 The response of the model was desired to be measured at three speeds: zero, one-half and one knot corresponding to zero, three and six knot prototype speeds.

6.6.2 The wave conditions for which the response was desired were 1/2 and 2.5 inch waves (1.2 and 6.0 feet prototype wave heights) and at varying frequencies.

6.6.3 The model was moved up the basin so that its line of motion was normal to the generated wave fronts.

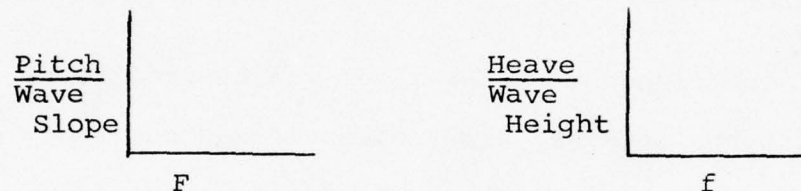
6.6.4 Eighteen runs were made under various conditions. On all runs the pitch, heave, speed and resistance of the model were recorded along with the wave records from the fixed gauges and the carriage wave gauge.

6.6.5 The natural frequency of the model was determined

by causing the vessel to respond purely in heave and pitch and measuring the amount of time necessary to complete ten cycles. The exciting force in each mode of freedom was continuously supplied by the experimenter.

6.7.0 Data. The data is presented both in tabular and graphical form on the following pages.

6.7.1 In order to best show the frequency response of the vessel the following graphs were plotted:



where:

$$\text{wave slope} = \frac{\pi H}{2L}$$

H = wave height

L = wave length

6.7.2 The natural frequencies in pitch and heave are presented below:

pitch - 1.34 cps

heave - 1.19 cps

Summary Sheet for Response Data

H = Max Waves

H = 1/2" Waves

	<u>Pitch</u>	<u>Heave</u>	$\lambda$	$f_e$	$f$	1/2	<u>Pitch</u>	<u>Heave</u>	$\lambda$	$f_e$	$f$
	<u>Wave</u>	<u>Slope</u>					<u>H</u>	<u>Wave</u>			
A-1							8.388	.046	2.5	1.68	1.43
A-2							3.408	.048	2.5	2.08	1.43
A-3							6.484	.1073	2.5	2.48	1.43
B-1	8.952	.076	3.125	1.50	1.28		11.628	.062	3.125	1.50	1.28
B-2	6.084	.06	3.125	1.82	1.28		6.816	.114	3.125	1.82	1.28
B-3	4.188	.037	3.125	2.14	1.28		7.536	.053	3.125	2.14	1.28
C-1	16.44	.074	3.75	1.37	1.16		22.08	.083	3.75	1.37	1.16
C-2	7.032	.10	3.75	1.63	1.16		22.2	.066	3.75	1.63	1.16
C-3	6.336	.044	3.75	1.90	1.16		9.996	.082	3.75	1.90	1.16
D-1	20.28	.055	5.0	1.19	1.01		45.48	.125	5.	1.19	1.01
D-2	19.08	.045	5.0	1.39	1.01		65.88	.182	5.	1.39	1.01
D-3	12.72	.031	5.0	1.59	1.01		37.8	.109	5.	1.59	1.01
E-1	35.28	.121	6.25	1.06	.91		70.2	.235	6.25	1.06	.91
E-2	22.92	.046	6.25	1.22	.91		80.4	.236	6.25	1.22	.91
E-3	17.52	.028	6.25	1.38	.91		83.16	.243	6.25	1.38	.91
F-1	43.08	.169	7.50	.971	.83		122.28	.283	7.5	.971	.83
F-2	61.92	.193	7.5	1.10	.83		83.76	.268	7.5	1.10	.83
F-3	44.16	.159	7.5	1.24	.83		72.96	.200	7.5	1.24	.83
G-1	48.72	.224	8.75	.899	.76		96.48	.377	8.75	.899	.76
G-2	58.44	.145	8.75	1.01	.76		94.2	.333	8.75	1.01	.76
G-3	59.4	.25	8.75	1.12	.76		108.5	.40	8.75	1.12	.76
I-1	42.96	.172	11.25	.793	.68		80.80	.430	11.25	.793	.68
I-2	50.76	.182	11.25	.881	.68		123.0	.431	11.25	.881	.68
I-3	42.96	.170	11.25	.969	.68		90.72	.434	11.25	.969	.68

H = 1/2" Waves

<u>Wave</u>	<u>H =</u>	<u>Wave Height</u>	<u><math>\lambda</math></u>	<u>T</u>	<u>f</u>	<u>Force</u>	<u>Heave</u>	<u>Pitch</u>
A-1	$\frac{1}{2}$	.41 .38	2.5	.699	1.43	.1	.019	.18
A-2	$\frac{1}{2}$	.42 .43	2.5	.699	1.43	.12	.02	.075
A-3	$\frac{1}{2}$	.41 .4	2.5	.699	1.43	.12	.044	.15
B-1	$\frac{1}{2}$	.39 .42	3.125	.781	1.28	.1	.024	.19
B-2	$\frac{1}{2}$	.35 .38	3.125	.781	1.28	.11	.04	.1
B-3	$\frac{1}{2}$	.38 .35	3.125	.781	1.28	.15	.02	.12
C-1	$\frac{1}{2}$	.48 .4	3.75	.856	1.16	.11	.04	.37
C-2	$\frac{1}{2}$	.45 .47	3.75	.856	1.16	.11	.03	.35
C-3	$\frac{1}{2}$	.43 .41	3.75	.856	1.16	.12	.035	.15
D-1	$\frac{1}{2}$	.44 .45	5.0	.988	1.01	.11	.055	.525
D-2	$\frac{1}{2}$	.44 .4	5.0	.988	1.01	.41	.08	.76
D-3	$\frac{1}{2}$	.58 .45	5.0	.988	1.01	.21	.063	.575
E-1	$\frac{1}{2}$	.51 .54	6.25	1.10	.91	.31	.12	.75
E-2	$\frac{1}{2}$	.38 .57	6.25	1.10	.91	.1	.09	.64
E-3	$\frac{1}{2}$	.39 .42	6.25	1.10	.91	.31	.095	.68

H = 1/2" Waves

<u>Wave</u>	<u>H =</u>	<u>Wave Height</u>	<u><math>\lambda</math></u>	<u>T</u>	<u>f</u>	<u>Force</u>	<u>Heave</u>	<u>Pitch</u>
F-1	$\frac{1}{2}$	.3 .45	7.5	1.21	.83	.4	.085	.64
F-2	$\frac{1}{2}$	.41 .4	7.5	1.21	.83	.25	.11	.6
F-3	$\frac{1}{2}$	.4 .36	7.5	1.21	.83	.41	.08	.51
G-1	$\frac{1}{2}$	.45 .47	8.75	1.31	.76	.65	.17	.65
G-2	$\frac{1}{2}$	.42 .48	8.75	1.31	.76	.4	.14	.57
G-3	$\frac{1}{2}$	.4 .52	8.75	1.31	.76	.62	.16	.65
I-1	$\frac{1}{2}$	.51 .46	11.25	1.48	.68	.63	.22	.48
I-2	$\frac{1}{2}$	.58 .65	11.25	1.48	.68	.7	.25	.86
I-3	$\frac{1}{2}$	.53 .47	11.25	1.48	.68	.45	.23	.56

<u>Wave #</u>	<u>Wave (in) Height</u>	<u>H = Max Waves</u>			<u>Force (lbs)</u>	<u>Heave (in)</u>	<u>Pitch (°)</u>
		<u><math>\lambda</math></u>	<u>T (sec)</u>				
B-1	2.24 2.62	3.125	0.781	.32	.17	.84	
B-2	2.00 2.22	3.125	0.781	.31	.12	.51	
B-3	2.16 2.46	3.125	0.781	.30	.08	.38	
C-1	2.70 2.80	3.75	0.856	.49	.20	1.55	
C-2	2.40 2.64	3.75	0.856	.45	.25	.59	
C-3	2.26 2.60	3.75	0.856	.25	.10	.50	
D-1	2.36 2.10	5.0	0.988	.70	.13	1.25	
D-2	2.42 2.40	5.0	0.988	.78	.11	1.21	
D-3	2.58 2.80	5.0	0.988	.50	.08	.86	
E-1	2.30 3.0	6.25	1.10	1.40	.28	1.70	
E-2	2.60 2.44	6.25	1.10	.79	.12	1.25	
E-3	2.48 2.92	6.25	1.10	.60	.07	.91	
F-1	2.18 2.70	7.50	1.21	1.82	.37	1.64	
F-2	1.96 3.40	7.50	1.21	2.01	.38	2.12	
F-3	2.20 3.00	7.50	1.21	1.50	.35	1.70	

Wave #	Wave (in) Height	H = Max Waves		Force (lbs)	Heave (in)	Pitch (°)
		$\lambda$	T (sec)			
G-1	2.14 2.4	8.75	1.31	1.74	.48	1.56
G-2	2.4 3.00	8.75	1.31	1.3	.35	2.1
G-3	2.0 2.8	8.75	1.31	1.7	.5	1.78
I-1	2.26 2.4	11.25	1.48	1.57	.39	1.13
I-2	2.2 2.2	11.25	1.48	1.08	.4	1.3
I-3	2.4 2.1	11.25	1.48	.71	.41	1.2

6.8.0 Data Analysis. The linear waves to which the model was subjected corresponded to prototype waves of 1.2 and 6.0 feet. This leaves a large spectrum of waves untouched but they give a good indication of the response of the vessel. It was seen that the model's response in pitch and heave decreased with increased wave height. This type of action would not be expected from a modern vessel.

6.8.1 Usually a vessel's pitching and heaving motions vary linearly with wave height. In other words, the higher the wave height, the more severe the vessel's motions.

6.8.2 The Monitor acted very differently from this because of the water taken on its deck. Each time the bow submerged, a significant amount of water was picked and acted as a damper to the system. Also, the water tended to cause the

bow to plow through the water rather than ride with it.

6.8.3 Normally a vessel's draft increases with increased speed because of the inverse relationship between velocity and pressure in a vessel moving through a fluid. This phenomenon causes an increased displacement from increased speeds. Although the experimental results do not indicate this clearly, it is believed that the response of the model decreased with increased speed, because of the added amount of water taken on deck at increased speeds.

6.8.4 The maximum pitching response of the vessel (at zero speed) occurred at a wave frequency of  $.8 \frac{\text{waves}}{\text{sec}}$ . The natural frequency of the vessel is 1.34 cps. It was expected that the maximum response of the model would occur at a wave frequency near its natural frequency. However, this is not the case because natural frequency was determined with no water on deck. The water added to the system resulting from the submergence of the deck caused the natural frequency of the vessel to decrease.

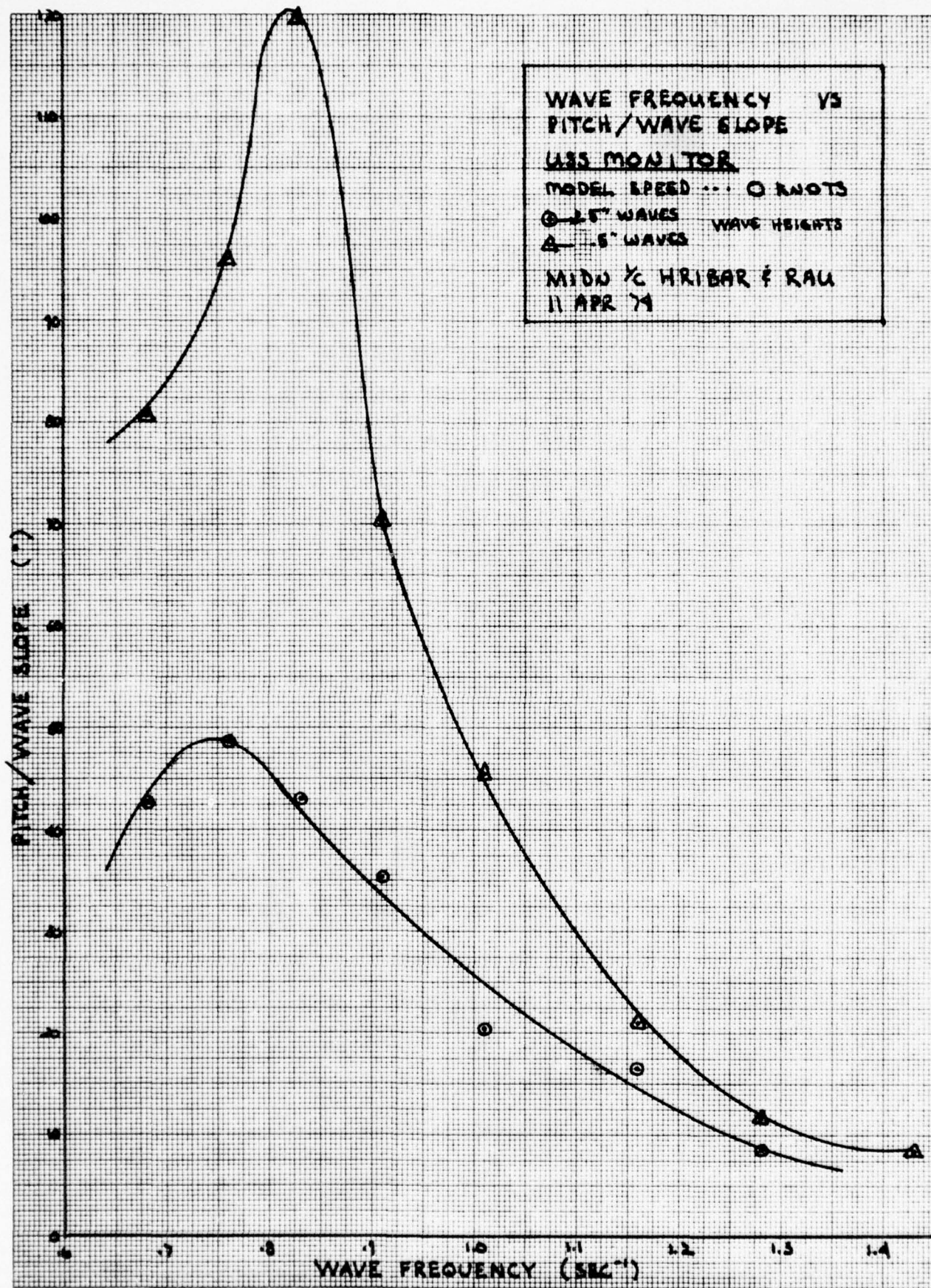
6.8.5 Thus far the analysis of data has concentrated on the effects of the weight of water on the model. However, can the model effectively represent the prototype with respect to the effects of water? Simply, surface tension does not scale. When the model is at rest, after a run, a film of water,

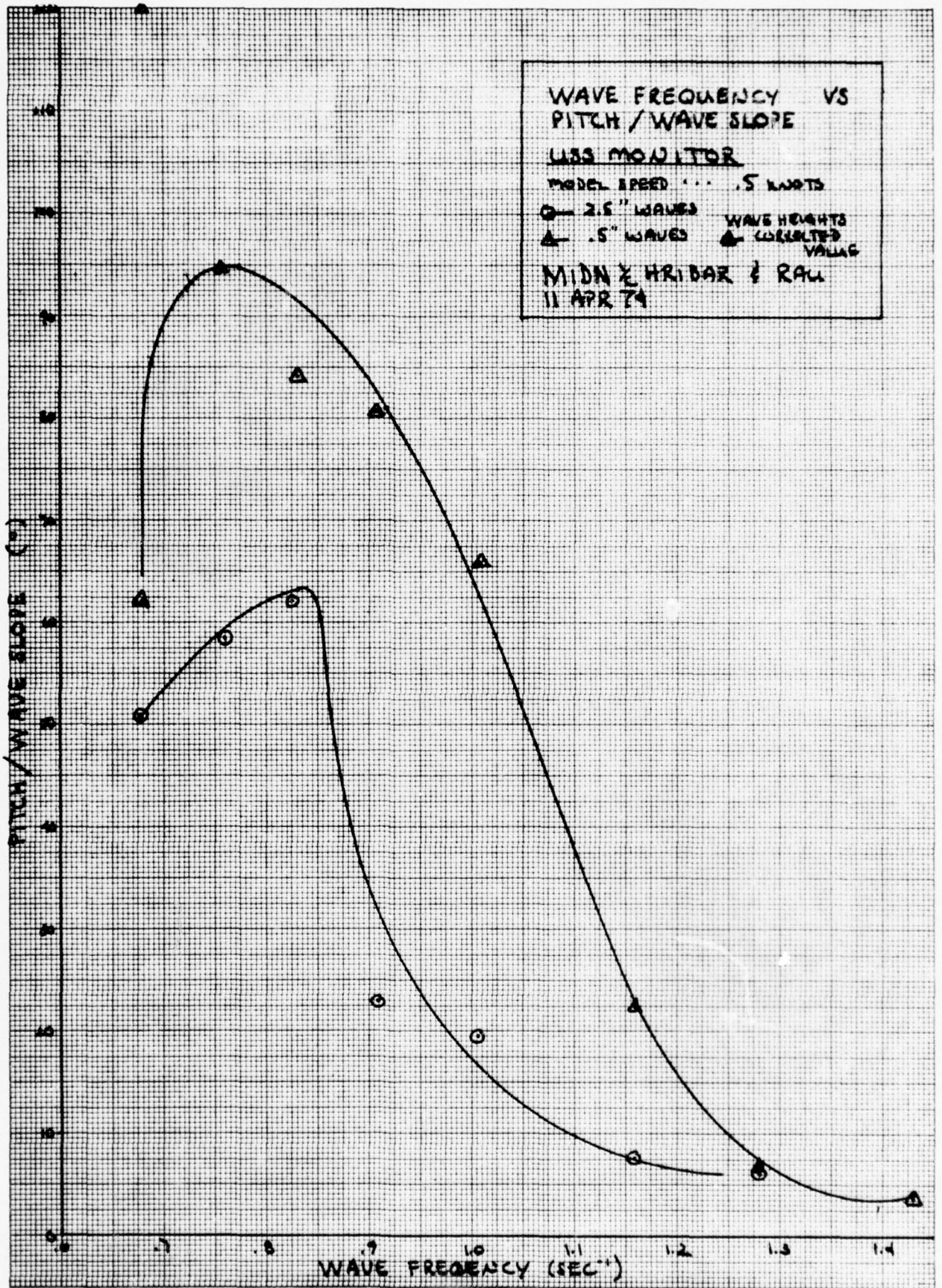
possibly 1/8" thick will remain on the deck. This scales up to a 4" layer on the prototype. Obviously this could never exist. This does not necessarily make model analysis incorrect, but it must be kept in mind that the damped response of the model may be somewhat exaggerated.

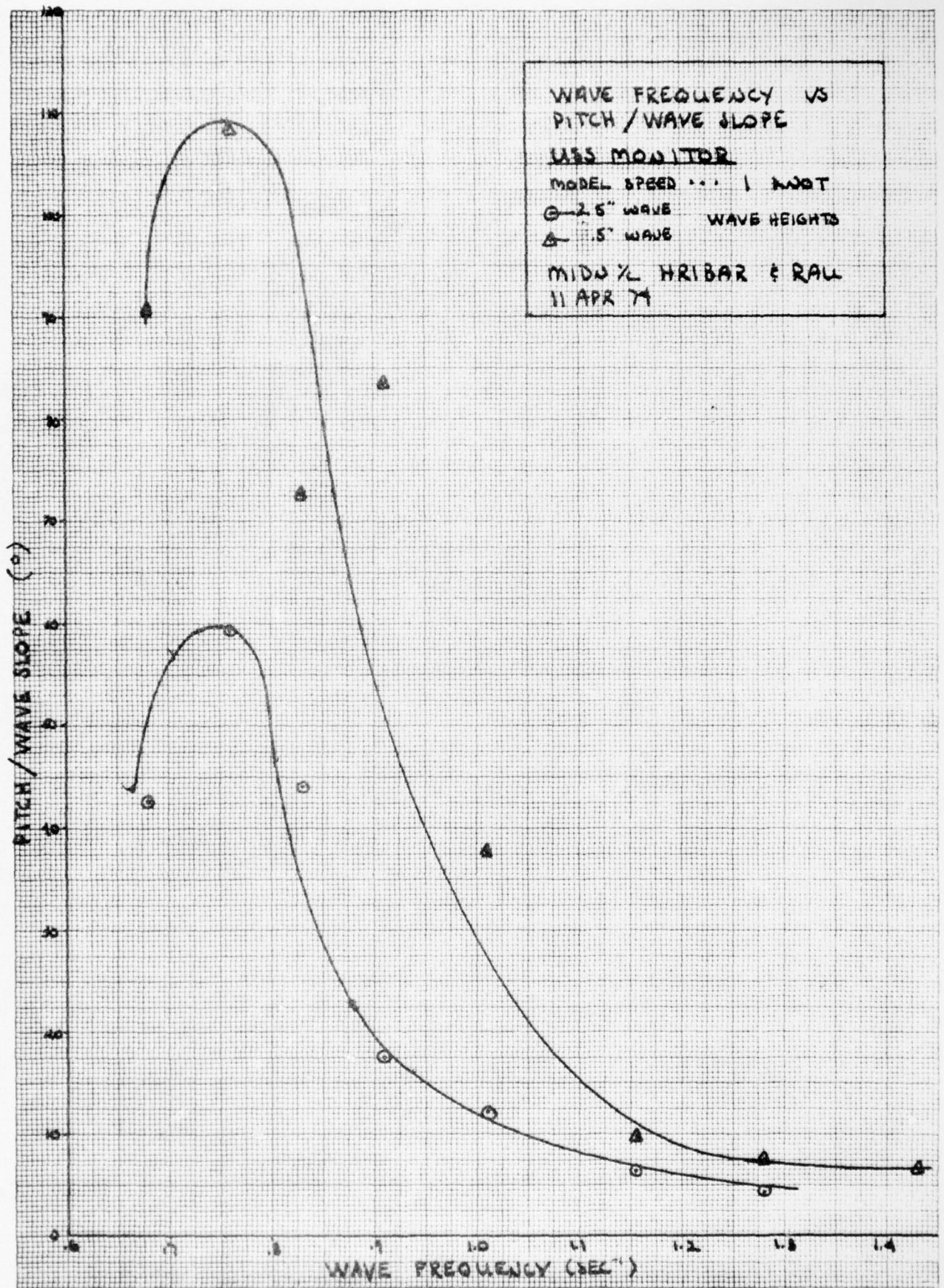
6.8.6 When looking at the heave/wave height vs. frequency curves, again the effects of water are readily visible. For a wavelength much greater than the length of the ship, heave/wave height should approach unity. (Much greater is defined as greater than 3 times ship length.) For this model that is a wave frequency of  $.58 \text{ sec}^{-1}$ . None of the graphs approach this response but again keep in mind surface tension.

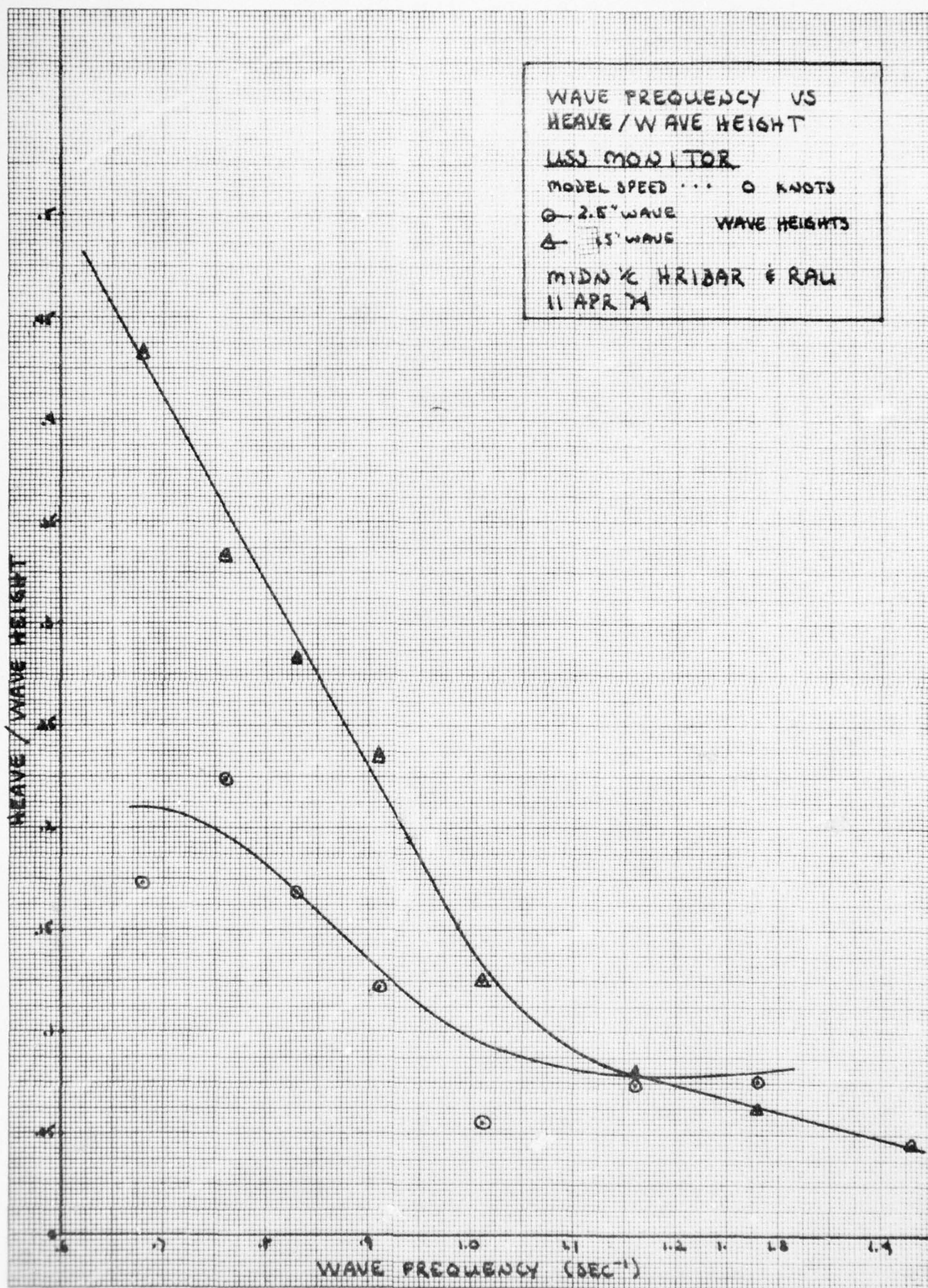
6.8.7 For the zero speed test side reflections must be considered. Waves which are radiated by the hull are reflected from the sides of the Model Basin. These waves tend to increase the vessel's response.

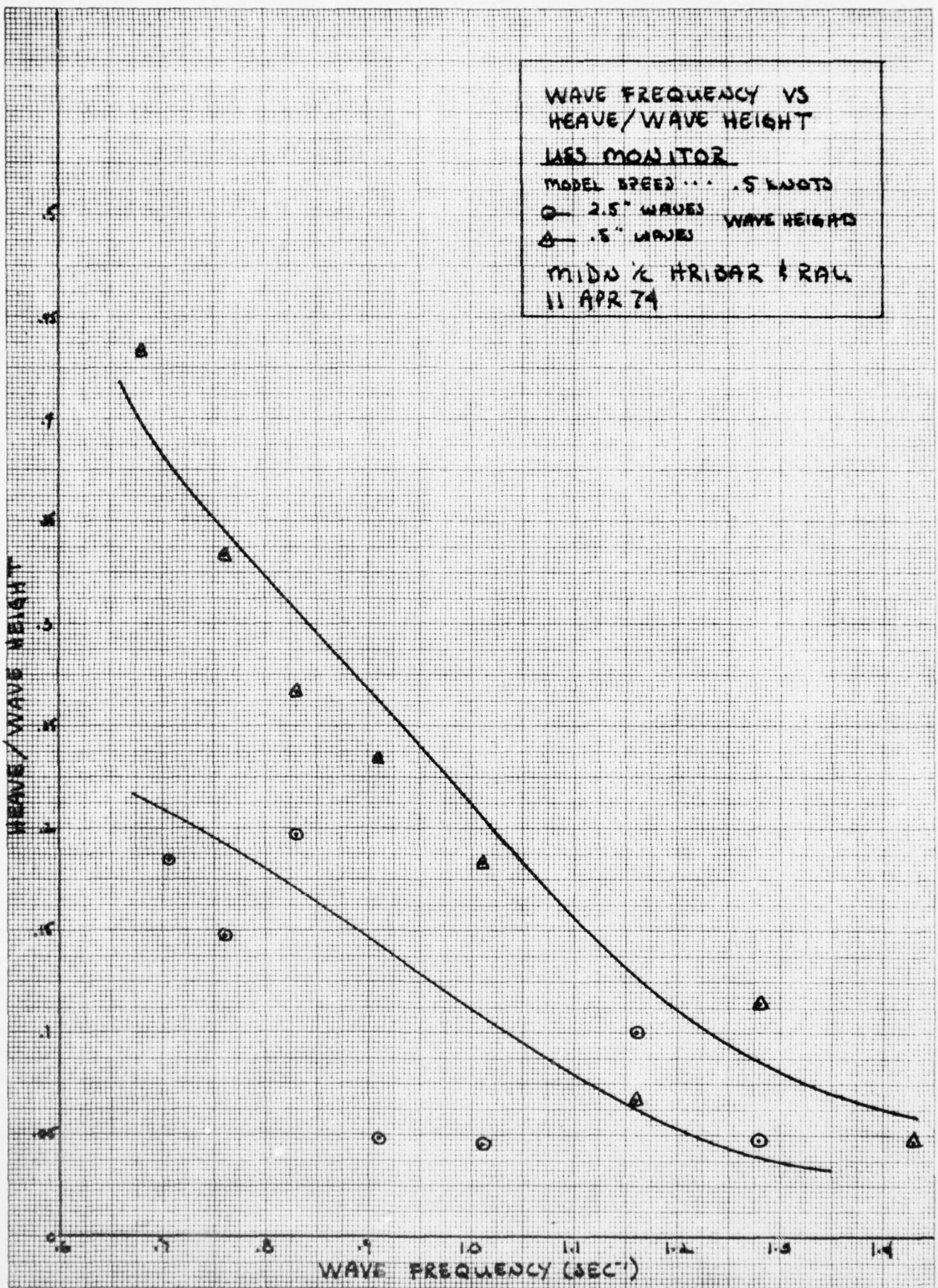
6.8.8 The linear tests of the Monitor showed that this vessel was rather stable in even rough seas when compared to its modern counterparts. Though designed for smooth waters, with a low freeboard, which presented a small target, the low freeboard acted as a scoop. When the seas got rough this scoop supplied the additional mass which damped out any oscillatory motion. The ride on a Monitor may have been wet, but relatively

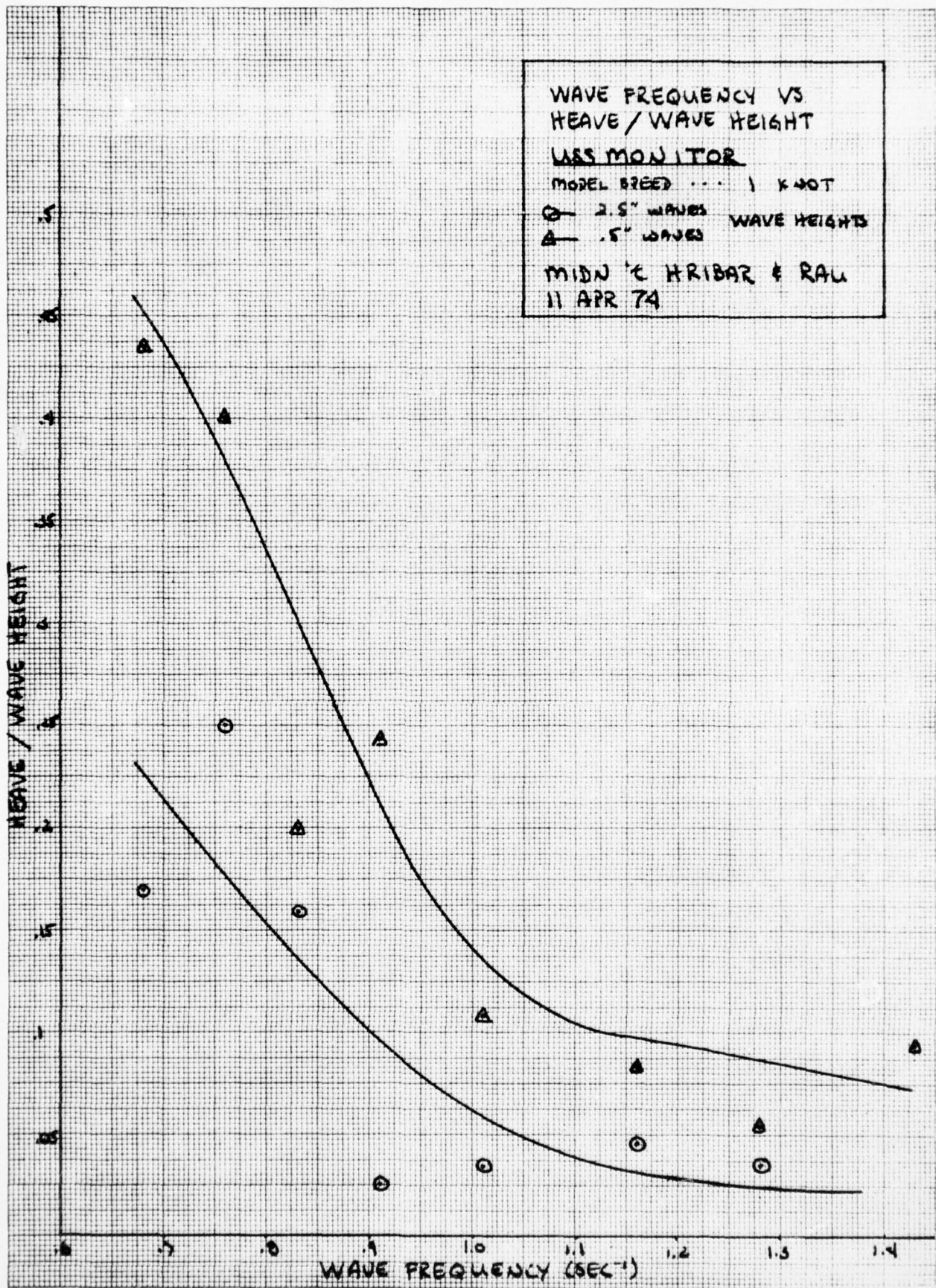












smooth. However, it must be kept in mind that surface tension plays a major part in the damping response. This phenomenon does not scale to the prototype and may cause the model tests to be somewhat inaccurate.

#### 7.0.0 TOWING RESPONSE

7.1.0 Background. The Monitor was being towed by the USS Rhode Island off Cape Hatteras, North Carolina when she encountered heavy weather and sank. The sea state, as recorded by survivors of the ship was about sea state 7.

7.1.1 The ship was towed from the extreme bow with two hawsers, an 11 inch circumference starboard and 15 inch circumference port. The towing length was about 300 feet.

7.2.0 Purpose. The purpose of the engineering analysis conducted was to simulate the above conditions and record the motion of the ship on film.

7.3.0 Procedure. In order to achieve the desired sea state, it was necessary to utilize the facilities of NSRDC, Carderock, Maryland.

7.3.1 The model was towed using two 3/16" diameter nylon lines attached. The actual length of each line was 8.6 inches corresponding to the actual 300 foot towing hawsers.

7.3.2 The eyebolts were positioned on the model in the

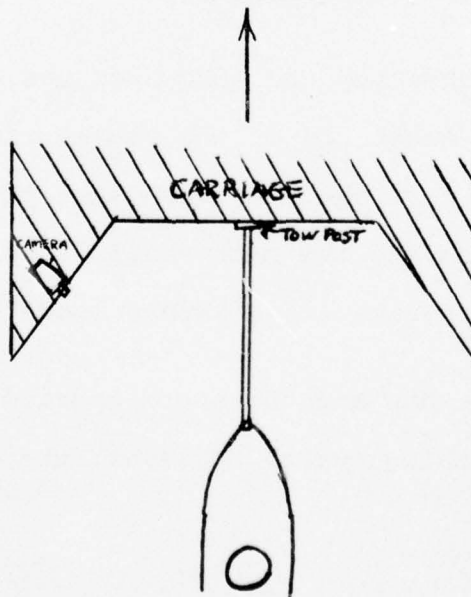
position occupied by the towing chocks on the prototype.

7.3.3 A low sea state 7 was generated and the model was towed heading into the waves.

7.3.4 Eight runs, at varying speeds were recorded on film. The run number and the corresponding speeds are listed below:

<u>Run #</u>	<u>Carriage Speed</u>	<u>Proto. Speed</u>
1	0.0	0.0 knots
2	.25	1.5
3	.50	2.9
4	.75	4.4
5	1.00	5.9
6	1.00	5.9
7	1.25	7.3
8	1.50	8.8

7.3.5 The camera was located above and to the port side of the model as shown below.



7.3.6 The significant wave height during the test was 17 feet with a maximum observed height of 20 feet. These parameters were noted by observing the wave motion as it passed a measuring device calibrated using a scale factor of 34.6.

7.4.0 Apparatus. Carriage II was used at NSRDC. The camera used was a high speed movie camera.

The film was shot at 96 frames per second in order to provide a scale factor of 6 when projected at 16 frames per second. By time scaling the response of the model, actual prototype motions were recorded.

7.5.0 Observations. Zero Speed. As was expected, the motions during this test were not extremely severe. Although the large metacentric height indicated that the response should be relatively severe, the linear wave tests indicated that this was not the case (See Section 6.0.0).

7.5.1 It was observed that the deck was awash almost continuously. The low freeboard of the vessel caused water to be taken on deck, both fore and aft, with each pitching motion. This water traveled along the deck until it crashed into various topside structures causing large impact loads.

7.5.2 Both the bow and the stern emerged from the water on almost every pitching cycle. However, there was no evidence

that slamming occurred at this speed.

7.5.3 The pilot house, the turret and the after smoke-stack were subjected to sizable impact loads due to the water on deck. It is very evident why the oakum packing was washed away from these structures.

7.5.4 A point that should be noted is the damping effect of the water on the motion of the ship. The effect of the water taken on deck was to act as a damper to the pitching motions. This added mass has a significant effect as is indicated by the recorded heave and pitch response in linear waves (See Section 6.0.0).

7.5.5 Towing speeds 1.5 to 5.9 knots. The response of the model when towed at these speeds was very similar to that which occurred at zero speed. A significant difference was noted however in the dampening effects of the water. As the towing speed increased, the degree of submergence of the bow and stern also increased. This naturally increased the amount of water which was taken on deck. This water tended to dampen the motions of the vessel even more severely which caused the motion of the vessel to approach that of a critically damped sinusoid. However, because the forcing function (the wave motion) was continuously being applied, it cannot be definitely concluded whether the water moved the system to a critically damped state.

7.5.6 A further consequence of the added water was the large impact loads which resulted on the pilot house and turret. The pilot house was submerged totally on the downward motion of the bow on almost every cycle. Since there was an opening into the inner hull around the pilot house, large amounts of water would enter the vessel in this manner.

7.5.7 The turret caused large amounts of water to spray up over its top. Since the turret was covered only by a grating, a large volume of water would necessarily have poured into the vessel from this entrance. It was also obvious that the oakum sealant which had been packed between the turret and the deck ring would have been washed away which would have resulted in water entering the vessel.

7.5.8 Slamming did not appear to be a critical problem at any towing speed up to 6 knots. However, there were two instances noted when slams did occur which would have put a severe strain on the junction between the two bodies. The shudder which was referred to in several accounts of the sinking were probably caused by the slugs of water crashing into the turret rather than slamming.

7.5.9 The weight of large amounts of water and the large resistance encountered when the bow pulled out of the water would endure very large bending moments amidships. Since there

was no continuity of support members in the vessel, it would necessarily be subjected to severe strain. However, since there was no instrumentation attached to the vessel, there can only be a qualitative judgment.

7.6.0 Conclusions. As was noted in Section 6.0.0, the response of the vessel was decreased as the severity of the ambient conditions increased. The mechanism by which this occurred was clearly seen in the films to be the water taken on deck. It was also apparent that large amounts of water would have entered the vessel around the turret and pilot house. Finally, these tests substantiated the reports that the vessel rode relatively easy in a sea way.

7.6.1 The reader is referred to various accounts of the sinking before viewing the films. The model acts exactly as the prototype was reported to have acted which lends substantial validity to all of the tests which were conducted.

#### 8.0.0 STRUCTURAL ANALYSIS

8.1.0 It is known that the wreck of the Monitor lies upside down in about 210 feet of water. Photographs of the site obtained from the Alcoa Seaprobe also indicate that the turret is significantly displaced from its original position but it is still underneath the overturned vessel.

8.2.0 This seems to be a sound hypothesis not only because of the information available but also because of the similarities

in the sinkings of the Monitor and the Tecumseh.

8.2.1 The Tecumseh is a second generation monitor which was sunk in Mobile Bay during the Civil War. We definitely know that the Tecumseh overturned within 38 feet from the surface and that the turret was not separated from the hull. However, it is believed that the turret structure is not sound and could easily be separated.

8.3.0 Because the hull form of the two vessels are similar, it is possible that the Monitor also overturned within 50 feet of surface. If this had occurred it is questionable if the turret would be held in place during the entire descent (over 200 feet) to the bottom.

8.4.0 Purpose. The purpose of this study was to determine whether the turret would be supported by the hull structure during the vessel's sinking if it were overturned.

8.5.0 Procedure. A worst-case analysis was done on the structure. By this is meant that the hull was assumed to be completely supported (upside down) with the entire weight of the turret assembly on the shaft and internal structured assembly. This, of course, would not be the case because both the turret and the hull would be supported by buoyant forces.

8.6.0 Discussion of Results. The buoyant weight of the turret (weight in air minus force of buoyancy) was determined to

be 100.9 tons. Since it was assumed that the shaft would part near the bearing, the weight of the shafts and the gear were necessary to be resisted. This yielded a total force tending to cause failure of 112.01 tons.

8.6.1 Assuming the above conditions the stress to which the shaft was subjected was found to be 4.46 ksi. This is significantly less than the ultimate tensile strength of the material.

8.6.2 It was next assumed that the structure would fail at point B. (See Structural Analysis of Turret Assembly) Consequently the weight of the gear and the shaft did not enter into these calculations. It was determined that each shaft would have to support 8.06 ksi which was also well within the allowable tensile strength of the material.

8.6.3 Finally it was assumed that the structure would fail at the rivets holding the turret to its supports. For this calculation only the buoyant weight of the turret and the guns was determined to be relevant. In order to ascertain the structural soundness of these rivets, it was necessary to examine three modes of failure:

- A. Shear failure of the shaft.
- B. Tensile failure of the retaining plate.
- C. Bearing failure of the retaining plate.

In all cases the material strength was sufficient to withstand the loads imposed upon the framing.

8.6.4 Even though the structural analysis indicated that the turret assembly would have satisfactorily resisted the loads on it, there is some question as to the type of bearing on which the shaft rested. A careful examination of the drawings available revealed that there was no consideration given for the support of a load which would have been applied if the vessel had turned over. This indicated that the turret may have pulled the entire assembly out of the bearing. Since the gear is attached to the turret shaft it would have been pulled through the interior of the hull, not necessarily passing through the deck. It is obvious that this type of failure would have caused considerable internal damage. The displacement of the turret probably occurred when the vessel reached the ocean bottom. The resulting impact probably caused the turret shaft to shear off.

9.0.0 PROPOSED SINKING by D. H. Rau.

9.1.0 When Duke University presented their evidence of discovery of the USS Monitor on 11 March 1974, several questions arose which were hard for Mr. Newton to explain. A few of these were how was it that the ship came to sit in a trough while it floundered in the treacherous waters off Cape Hatteras and how could the hull settle with the turret positioned so far aft?

9.2.0 Following Mr. Peterkin's research and chronological reproduction of the events on 31 December 1862, there originally

seemed to be some incongruencies which to me have finally made some sense. It was believed that due to slamming or a poor anchor housing, flooding occurred forward. This would obviously make the ship angle down in the bow which would increase the flooding and pitch angle. However, when the tow hawsers to the Rhode Island were cut, the Monitor turned away from the seas which would suggest more weight was astern. When the Monitor left Hampton Roads on 29 December 1862 for Beaufort, North Carolina, there was no record of precisely what was on board. Ballasting could easily have made the bow light. Due to poor compartmentation any water which might have entered would quickly flow to the stern and enhance the problem.

9.3.0 When the anchor was released, the ship began to turn into the seas as the anchor began to catch. However, releasing the anchor, released some 19.7 tons from the forward section of the ship. Having no moment to alter the trim one inch of 42 foot tons, (table of offsets), this would mean that the bow would normally raise about 4-5" increasing the flooding in the stern. Considering this, I suggest the Monitor sank stern first.

9.4.0 The question of turning over seems relatively simple. On the surface, a ship has a center of gravity which sits higher than the center of buoyance. As the ship rolls and pitches, the center of buoyancy moves (the center of buoyancy

is the geometric center of the underwater hull). This creates a moment which tries to correct the disposition. As the Monitor flooded, the center of gravity lowered, however, the center of buoyancy became more stationary as freeboard was lost. Sinking lower and lower the ship passed through a period of instability, where the moment caused by the center of gravity and buoyancy was actually trying to tip the ship over. A large wave just off the bow could easily initiate this reaction which would upset the stability of the hull. Because of the relatively small amount of buoyancy in the turret the capsize probably occurred when the deck was awash or just below the surface. Last reports from rescue crews stated that the deck was already awash with no freeboard remaining.

9.5.0 Once capsized and under water the stern would probably sink fastest with all remaining buoyancy in the bow. According to calculations done by Midshipman Hribar, the Monitor could set upside down without the turret falling off, however, it would shear if the forces were not longitudinal with the supporting pins. This would suggest that the turret might fall off as the ship rotated or as it hit bottom, if it hit at an angle. Personally, I feel that the hull would have sunk in a hurry, stern first once the stage of critical instability was reached. Upside down and angled in the stern, all buoyancy would be quickly lost as water rushed into a forward hole. Quickly, though it is relative because the vessel

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was 173 feet long and was lost in 220 feet stern continued to sink, the bow would try and the ship probably hit bottom before the lifting air.

9.6.0 Upon striking bottom the turret would and fall directly down as the hull pivoting come to settle down on top. This explains now so far to the stern when it used to sit center of the deck.

9.7.0 In making this proposed sinking I as tions and I am basing my ideas on several o culations. Buoyancy figures could be run t much water was on board to cause the appare board, however, conditions and calculations determine considering the adverse sea state

#### 10.0.0 RECOMMENDATIONS

10.1.0 Although this study was very succes several areas in which it could be improved

10.2.0 The first area of improvement conce though we achieved a gyradius of 21% of the the response may have been slightly more ac of 25% of  $L_{pp}$  was used. This could be acco imately 25 pounds of ballasting weight were model exactly at its center of gravity. Th

would have to be routed out forward and aft and plexiglass hatch covers fabricated. The ballasting weight could then be moved as far forward as desired in order to achieve the desired gyradius.

10.3.0 A study which was excluded because of the lack of time and facilities was that of the response of the model at anchor. This study could be very useful in determining how the Monitor acted after the anchor had been dropped during the storm. The model was constructed with provisions made for anchorage studies.

10.4.0 Finally, if more accurate information would become available on the weight distribution of the Monitor, stability curves could be constructed and a progressive flooding study could be conducted.

Appendix A

A-1-0 The following is a program to calculate the sectional areas of the U.S.S. Monitor written by Midshipman Herbert Hribar with the assistance of Midshipman Rolf Dietrich.

A-1-1 The program is written in BASIC and was run on the U. S. Naval Academy time sharing system.

CALCULATIONS OF THE SECTIONAL AREAS OF THE USS MONITOR

---

- 1 -

SECTION

```
90 DIM R(54)
100 FOR B=0 TO 16 STEP 2
110 INPUT X(2),X(3),X,Y(1)
120 LET A(1)=3.65*X
130 LET A(2)=6.5*X(3)
140 LET A(3)=0.5*XH2)*Y(1)
150 LET R(B)=2*(A(1)+A(2)+A(3+))
160 NEXT B
170 FOR B=18 TO 34 STEP 2
180 LET R(B)=R(16)
190 NEXT B
200 PRINT "**"
210 FOR B=36 TO 54 STEP 2
220 INPUT X(2),X(3),X,Y(1)
230 LET A(1)=3.69*X
240 LET A(2)=6.5*X(3)
250 LET A(3)=0.5*X(2)*Y(1)
260 LET R(B)=2*(A(1)+A(2)+A(3))
270 NEXT B
280 FOR T=1 TO 6
290 PRINT
300 NEXT T
310 FOR Y=1 TO 70
320 PRINT "=" ;
330 NEXT Y
340 PRINT
350 PRINT,"STATION","SECTIONAL"
360 PRINT,"NUMBER","AREA IN FT2"
370 FOR D=0 TO 54 STEP 2
380 PRINT ,D,R(D)
390 NEXT D
400 PRINT
410 FOR V=1 TO 70
420 PRINT "=" ;
430 NEXT V
440 FOR L=1 TO 6
450 PRINT
460 NEXT L
470 END
```

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CALCULATIONS OF THE SECTIONAL AREAS OF THE USS MONITOR

---

STATION NUMBER	SECTIONAL AREA IN FT <sup>2</sup>
0	19.71
2	54.896
4	85.483
6	130.34
8	191.532
10	261.774
12	300.533
14	318.013
16	318.078
18	318.078
20	318.078
22	318.078
24	318.078
26	318.078
28	318.078
30	318.078
32	318.078
34	318.078
36	318.959
38	297.834
40	280.804
42	164.446
44	148.633
46	138.965
48	125.312
50	106.42
52	81.7704
54	50.8482

---

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Appendix B

B-1-0 The following is a program written by Midshipman Herbert Hribar with the assistance of Midshipman Rolf Dietrich which computes the location of the center of gravity for the Monitor.

B-1-1 The program is written in BASIC and was run on the Naval Academy time sharing system.

COMPUTATIONS OF THE LOCATION OF THE CENTER OF GRAVITY FOR THE  
MONITOR

-1-

CG

```
100 PRINT "HOW MANY WEIGHTS ARE YOU CONSIDERING?"
110 INPUT N
120 FOR B= 1 TO N
130 PRINT "WHAT IS THE X COMPONENT OF WEIGHT";B;
140 PRINT "(X DIRECTION IS POSITIVE FORWARD)"
150 INPUT X
160 PRINT
170 PRINT "WHAT IS THE Y COMPONENT OF WEIGHT";B;
180 PRINT "(Y DIRECTION IS POSITIVE TO STARBOARD)"
190 INPUT Y
200 PRINT
210 PRINT "WHAT IS THE Z COMPONENT OF WEIGHT";B;
220 PRINT "(Z DIRECTION IS POSITIVE UP)"
230 INPUT Z
240 PRINT
250 PRINT "WHAT IS THE WEIGHT OF WEIGHT";B;
260 INPUT W
270 PRINT
280 LET X(2)=X(2)+X*W
290 LET Z(2)=Z(2)+Z*W
300 LET Y(2)=Y(2)+Y*W
310 LET W(2)=W(2)+W
320 NEXT B
330 LET X(1)=X(2)/W(2)
340 LET Y(1)=Y(2)/W(2)
350 LET Z(1)=Z(2)/W(2)
360 FOR I=1 TO 10
370 PRINT
380 NEXT I
390 FOR A= 1 TO 70
400 PRINT "=";
410 NEXT A
420 FOR A=1 TO 6
430 PRINT
440 NEXT A
450 IF X(1)<0 THEN 480
460 LET X$="FOREWARD"
470 GO TO 500
480 LET X(1)=ABS(X(1))
490 LET X$="AFT"
500 IF Y(1)<0 THEN 530
510 LET Y$="STARBOARD"
520 GO TO 550
530 LET Y(1)=ABS(Y(1))
540 LET Y$="PORT"
550 PRINT "THE LONGITUDINAL CENTER OF GRAVITY IS";X(1);"FEET"
560 PRINT X$; " OF THE LONGITUDINAL CENTERLINE"
570 PRINT
580 PRINT
590 PRINT
```

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COMPUTATIONS OF THE LOCATION OF THE CENTER OF GRAVITY FOR THE  
MONITOR

-2-

CG (CONTINUED)

```
600 PRINT "THE TRANSVERSE CENTER OF GRAVITY IS";Y(1);"FEET"  
610 PRINT Y$; " OF THE TRANSVERSE CENTERLINE"  
620 PRINT  
630 PRINT  
640 PRINT  
650 PRINT  
660 PRINT "THE VERTICAL CENTER OF GRAVITY IS ";Z(1);"FEET"  
670 PRINT "ABOVE THE BASELINE"  
680  
690 FOR A=1 TO 6  
700 PRINT  
710 NEXT A  
720 FOR A=1 TO 70  
730 PRINT "=";  
740 NEXT A  
750 FOR F=1 TO 10  
760 PRINT  
770 NEXT F  
780 END
```

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Appendix C

C-1-0 The natural frequencies of the Monitor in pitch and heave were determined by causing the model to oscillate with these motions and then measuring the time necessary to complete 10 cycles. This time was then totaled and divided by 10 to get the natural frequencies. Each test was conducted 10 times and the results averaged

C-1-1 The natural frequency in pitch is 1.35 cps.

C-1-2 The natural frequency in heave is 1.19 cps.

C-1-3 The tabulated results of the times obtained to complete 10 cycles is listed below:

Pitch	1	7.4 secs	7.2
	2	7.8 secs	7.4
	3	7.8	7.4
	4	7.4	7.4
	5	7.4	7.4
Heave	1	8.0	8.8
	2	8.2	8.5
	3	8.2	8.0
	4	8.6	8.3
	5	8.6	8.6

1017 Begin setting model on force block

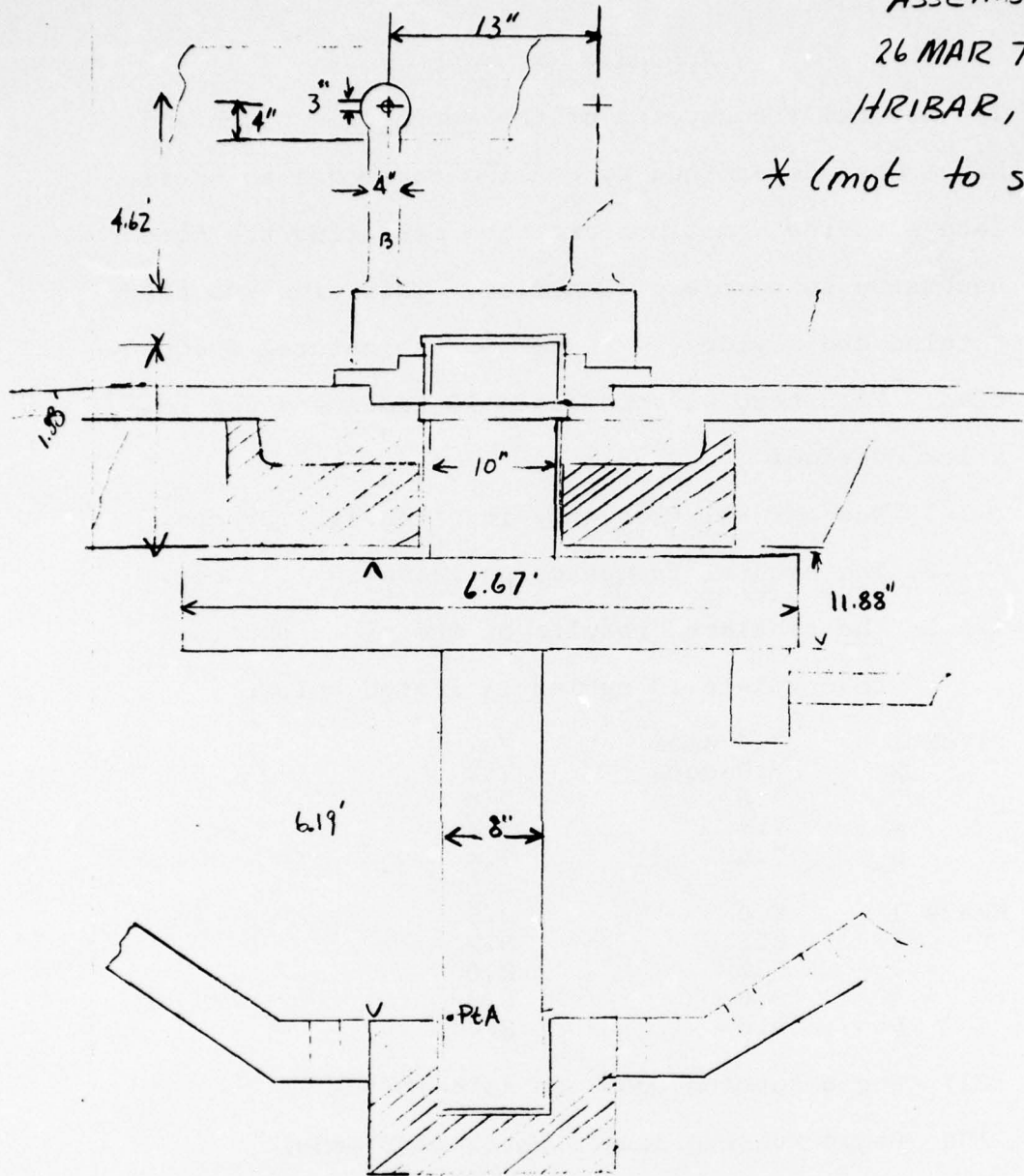
1100 Begin running linear waves past model

MONITOR TURRET  
ASSEMBLY.

26 MAR 74

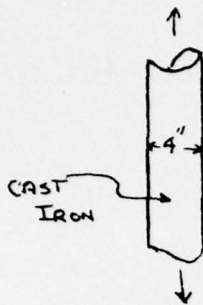
HRIBAR, HR.

\* (not to scale)



STRUCTURAL ANALYSIS OF TURRET ASSEMBLY

- I. Case A, assume pins will hold load; will the shaft hold the load of the turret?



$$\sigma = \frac{P}{A}$$

wrought  
iron

$$\sigma_{\text{yield}} = 31,000 \text{ psi} = 4.464 \times 10^6 \frac{\text{lbs}}{\text{ft}^2}$$

$$\sigma_{\text{ultimate}} = 51,000 \text{ psi} = 7.34 \times 10^6 \frac{\text{lbs}}{\text{ft}^2}$$

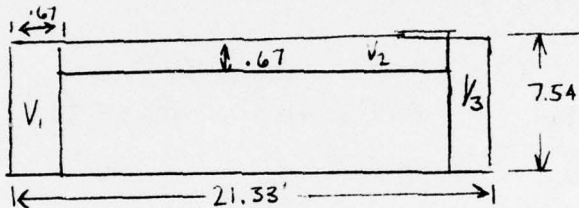
cast  
iron

$$\sigma_{\text{yield}} = 17,000 \text{ psi}$$

$$\sigma_{\text{ultimate}} = 20,000 \text{ psi}$$

$$E = 13 \times 10^6 \text{ psi}$$

- A. Assume turret fills with water through grate:



$$A_1 = 5.03 \text{ ft}^2 \Rightarrow V_1 = (2.7)(10.66) = 337.06 \text{ ft}^3$$

$$A_2 = 14.29 \text{ ft}^2 \quad V_2 = (2.7)(10.66)(14.29) = 958.02 \text{ ft}^3$$

$$A_3 = A_1 = 5.03 \text{ ft}^2 \quad V_3 = 377.06 \text{ ft}^3$$

$$i \quad V_t = 24.35 \text{ ft}^2 \quad V_T = 1712.14 \text{ ft}^3$$

$$SG = 7.4 = \frac{\gamma_{wI}}{\gamma_w} \Rightarrow (7.4)(62.4) = \gamma_{wI} = 461.76 \text{ lbs/ft}^3$$

$$FB = (\gamma_w)(V_T) = 64.0 \text{ lbs/ft}^3 (1712.14) =$$

$$FB = 54.79 \text{ Tons} = 109,577.23 \text{ lbs}$$

$$F_{\downarrow} = 155.67 \text{ Tons}$$

$$\Delta F = 100.88 \text{ Tons} = 201,760 \text{ lbs}$$

Wt of shaft:



length of 8" shaft = 6.19' (SG = 7.00 - 7.22)

$$SG = \frac{\gamma_{cast}}{\gamma_{water}}$$

$$\gamma_{cast} = (62.1 \frac{lb}{ft^3}) \times 7.00 = 436.8 \frac{lb}{ft^3}$$

length of 10" shaft = 1.88'

length of 4" shaft = 4.62'  
(2 4" shafts)

Wt of 8" shaft =

$$A_{8"} = \pi r^2 = (\pi) (\frac{8}{2})^2 = 50.27 \text{ in}^2 = 1.40 \text{ ft}^2$$

$$V_{8"} = (1.40) (6.19) = 8.67 \text{ ft}^3$$

$$A_{10"} = (\pi) (\frac{10}{2})^2 = 78.54 \text{ in}^2 = 2.18 \text{ ft}^2$$

$$V_{10"} = (2.18) (1.88) = 4.10 \text{ ft}^3$$

$$A_{4"} = (\pi) (\frac{4}{2})^2 = 12.57 \text{ in}^2 = .35 \text{ ft}^2$$

$$V_{4"} = (.35) (4.62) = 1.62 \text{ ft}^3$$

$V_{total}$  of two shafts = 3.24 ft<sup>3</sup>

Total Volume of cast iron = 15.98 ft<sup>3</sup>

Total Wt. of shaft = (15.98) (436.8) = 6980.06 lb  
= 3.49 tons

If it can be considered that shaft is not above the lower bearing (Pt. A) then the weight of the shaft and that of the main gear must be considered.



$$A = \pi R^2 = \pi (3.34)^2 = 35.03 \text{ ft}^2$$

$$V = (\pi R^2) h = (35.03) (.99) = 34.99 \text{ ft}^3$$

$$Wt_{gear} = (34.99) (436.8) = 15,205.2 \text{ lbs}$$

$$Wt_{gear} = 7.64 \text{ tons}$$

CALCULATIONS FOR THE STRESS AT POINT A, (ASSUME ALL SUPPORTS WILL HOLD).

FROM PG 1:

F<sub>B</sub> ↑ of the turret = 109,577.2 lbs = 54.8 tons

F<sub>T</sub> ↓ (wt. of turret including 2 Guns) = 311,400 lbs = 155.7 tons

FROM PG 2:

F<sub>S</sub> ↓ (weight of shaft above Point A) = 6980.1 lbs = 3.5 tons

F<sub>G</sub> ↓ (weight of gear) = 15,285.2 lbs = 7.6 tons

F<sub>↓</sub> = Total force down = 166.8 tons = 333,600 lbs

F<sub>B</sub> ↑ = Total buoyant force of turret = 54.8 tons = 109,577.2 lbs

F<sub>↓</sub> - F<sub>B</sub> = 333,600 - 109,577 = 224,023 lbs ↓

σ = P/A

A = π r<sup>2</sup> = (π)(4")<sup>2</sup> = 50.2 in<sup>2</sup>

σ = 224,023 / 50.2 = 4,462.6 lbs/in<sup>2</sup>

this is well within allowable limits:

CALCULATIONS FOR STRESS AT POINT B:

FROM PG. 1:

F<sub>B</sub> ↑ of the turret = 54.8 tons = 109,577.2 lbs

F<sub>T</sub> ↓ weight of turret = 155.7 tons = 311,400 lbs

FROM PG 2:

F<sub>S</sub> ↓ (weight of 4" SHAFTS) = 1415.2 lbs = .707 TONS

W<sub>A</sub> = (3.24 ft<sup>3</sup>)(436.8) = 1415.2 lbs

F<sub>↓</sub> - F<sub>B</sub> = 312,831.2 - 109,577.2 = 203,254.2 lbs

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$$F_{T\downarrow}/2 = 101,627 \text{ lbs}$$

$$\sigma = 101,627/A_s$$

$$A_s = (\pi)(2")^2 = 12.6 \text{ in}^2$$

$$\sigma = 101,627/12.6 = 8065.6 \text{ lbs/in}^2$$

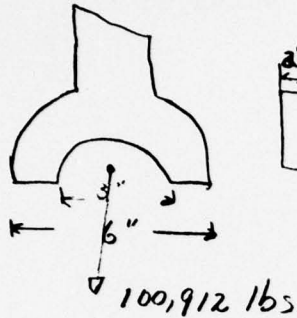
this is also well within the strength  
of the material

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CALCULATIONS FOR SHEAR  
OF PINNED SURFACES:

5

(1) TENSILE ULTIMATE STATIC LOAD



$$\sigma = \frac{P}{t(P-d)} = \frac{100,912}{(2'')(6-3'')}$$

$$\sigma = 16,818.7 \text{ lbs/in}^2$$

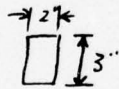
\* ASSUME 2" THICKNESS

(2) SHEARING ULTIMATE STATIC LOAD



$$\tau = \frac{P}{A_s} = \frac{100,912}{28.26} = 3570.8 \text{ lbs/in}^2$$

(3) Bearing ULTIMATE STATIC LOAD



$$\sigma = \frac{P}{td} = \frac{100,912}{6 \text{ in}^2}$$

$$\sigma = 16,818.7 \text{ lbs/in}^2$$

$$\sigma_{CI \text{ yield}} = 17,000 \text{ psi}$$

$$\sigma_{\text{ULTIMATE}} = 20,000 \text{ psi}$$

Reference: ELEMENTARY MECHANICS OF DEFORMABLE BODIES by SMITH & SIDEBOTTOM

qut

Appendix D

D-1-0 This appendix contains the materials study conducted by NSRDC, Annapolis, Maryland on plates salvaged from the U. S. S. Tecumseh.

ALAN H. ROSENSTEIN

*Aug. 30, 1967*



DEPARTMENT OF THE NAVY  
NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER  
Successor to David Taylor Model Basin and Navy Marine Engineering Laboratory  
ANNAPOLIS, MARYLAND 21402

IN REPLY REFER TO  
NP/10310(M864 AHR)  
Assigt 87-310

ANNAPOLIS DIVISION

30 AUG 1967

From: Officer in Charge  
To: Commander, Naval Ship Engineering Center (SEC 6101D)  
Subj: USS TECUMSEH; Mechanical Testing of Hull Samples  
Encl: (1)-(3) Photographs of Samples  
(4) Tensile Test Results

1. Hull samples from the USS TECUMSEH were forwarded to ANNADIV NSRDC for determination of tensile and yield strengths to aid in salvage operations. The samples are shown in Enclosures (1), (2) and (3). Samples used in testing are identified as Pieces A, B, and D. Only Piece B had a tag attached, identifying it as Hull Sample #5, Starboard, Frame 97, Strake C.
2. Samples were cleaned by sandblasting, and cut into longitudinal and transverse flat tension specimens similar to the sheet-type tensile specimens described by ASTM E8-66. Some specimens were tested with the surface in the as-cleaned condition, and other specimens had machined (smooth) surfaces. Tensile results are shown in Enclosure (4).
3. During Mr. Earl Lawrence's (NAVSHIPS, SHIPS 00C) visit of 16 August 1967, these results were reviewed and discussed, and several tested specimens and a polished and etched macrosection through the rivets of Piece D were provided for his use.
4. Mr. Paul Beaver of National Geographic Magazine accompanied Mr. Lawrence and photographed the test equipment and specimens. It was agreed that clearance for release of photographs and information to National Geographic will be obtained by NAVSHIPS (SHIPS 00C). However, it is requested that ANNADIV NSRDC be given the opportunity to approve the correctness of reporting of any information obtained from the Laboratory.

*W. P. Williams*

Copy to:  
NAVSHIPS (SHIPS 00C)  
(Attn: Mr. E. Lawrence)

COPY AVAILABLE TO DDC DOES NOT  
PERMIT FULLY LEGIBLE PRODUCTION

NP/1031 (664 AHR)

ANNADIV NSRDC

Assigt 87-310

Tensile Test Results

Piece	Specimen	Orientation	Tensile Strength, 1000 PSI	0.2% Yield Strength, 1000 PSI	Approximate Thickness After Cleaning by Sandblasting, Inch	Thickness When Machined to Uniform, Sound Metal, Inch
A	EMQ-3	Longitudinal	43	29	0.30 +0.07	0.131
	4	"	44	31	"	0.131
	1	Transverse	37	-	"	0.150
	2	"	40	33	"	0.131
B	EMQ-11	Longitudinal	57	-	0.32 +0.03	0.271
	12	"	54	38	"	0.228
	13	Transverse	41	38	"	0.231
	14	"	44	39	"	0.228
	15	"	41	-	"	(1)
	16	"	38	32	"	(1)
D	EMQ-57	Longitudinal	54	-	0.33 +0.05	(1)
	58	"	52	36	"	(1)
	59	"	57	38	"	0.227
	60	"	58	39	"	0.271
C	Not tested			0.56 +0.03	0.420	
E	Not tested			0.32 +0.04	Not available	

(1) These specimens were tested in the as-cleaned condition. All others were machined to the indicated thickness before testing.

## Appendix E

E-1-0 The following pictures are of specific apparatus used in this study.

Figure E-1 - wave guage

Figure E-2 - towing carriage

Figures E3 & E-4 - strip chart recorders

Figure E-5 - Force Block

Figure E-6 - U.S.N.A. Model Basin

Figure E-7 - Model Ready for testing

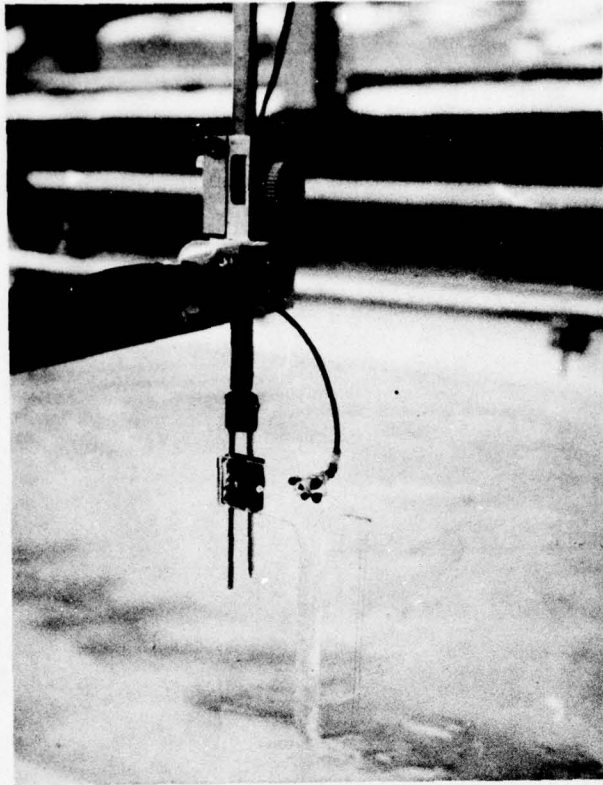


Figure E-1 -  
Wave Guage

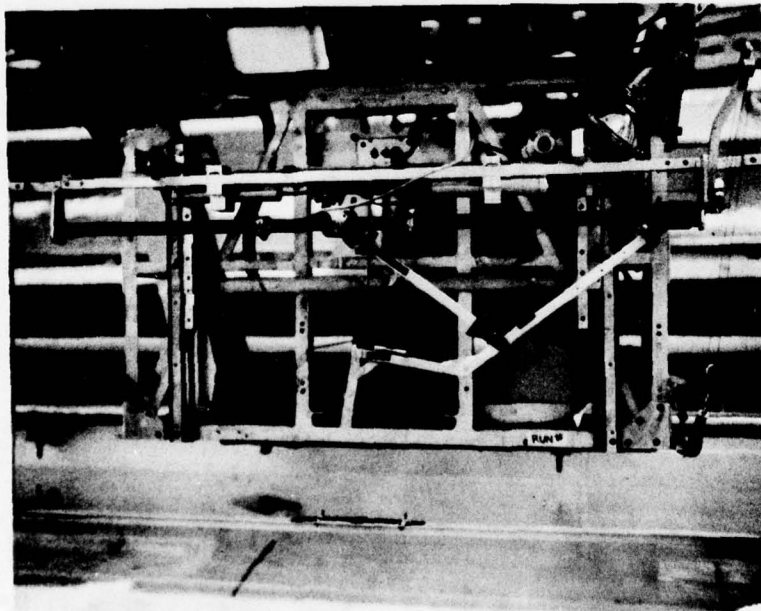
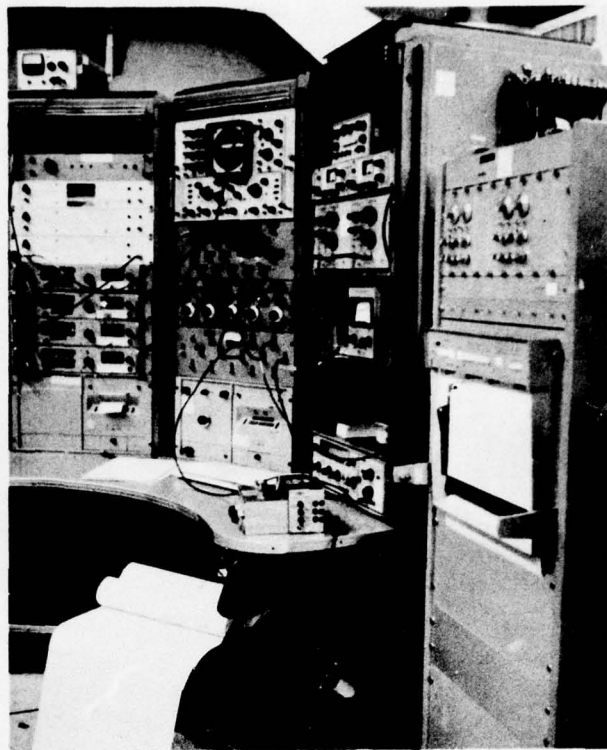


Figure E-2 -  
Towing Carriage

Figure E-3



Strip Chart Recorders

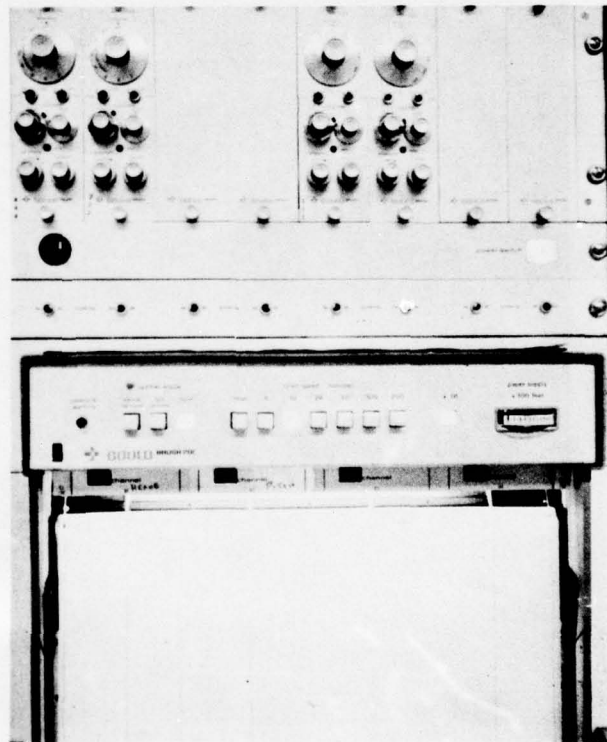


Figure E-4

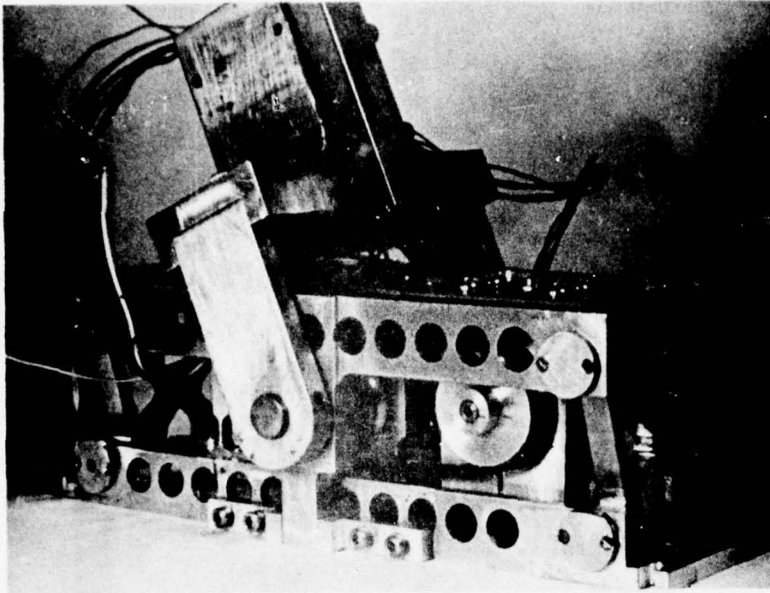


Figure E-5 -  
Force Block

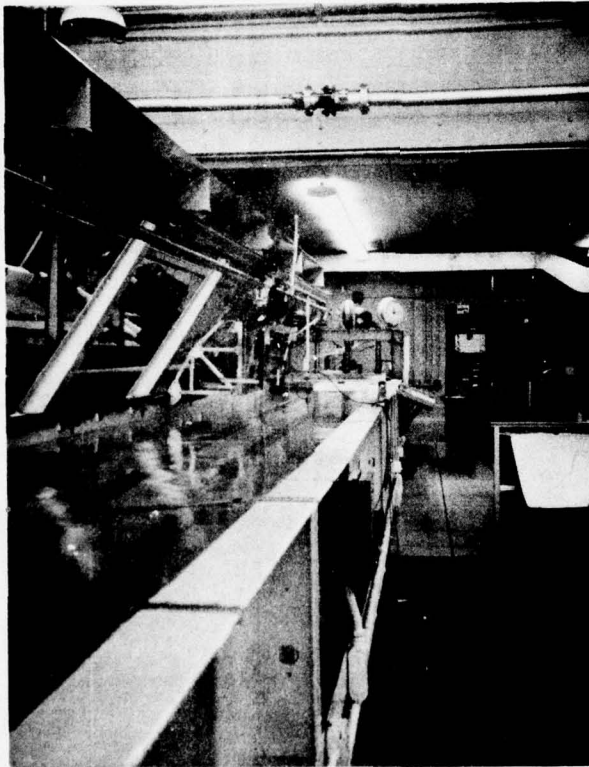


Figure E-6 -  
U.S.N.A. Model Basin

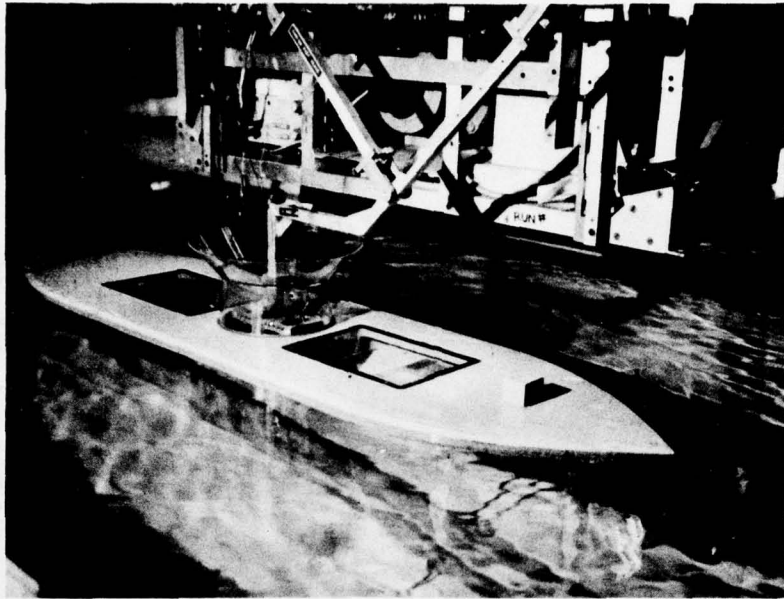
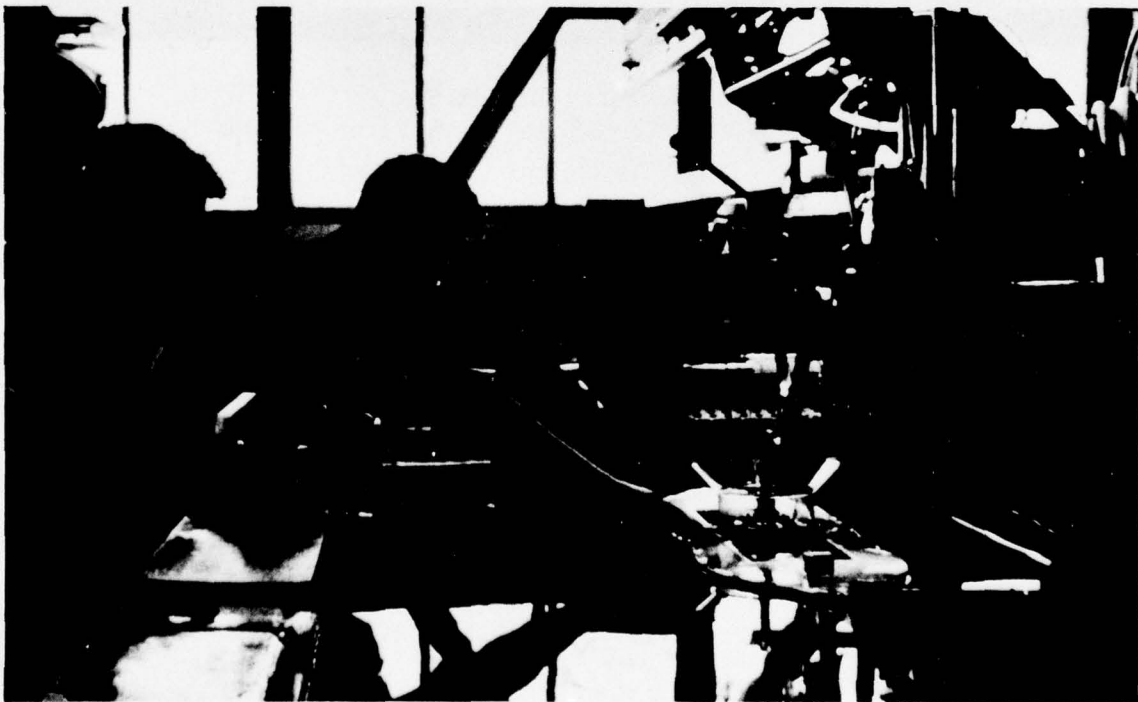
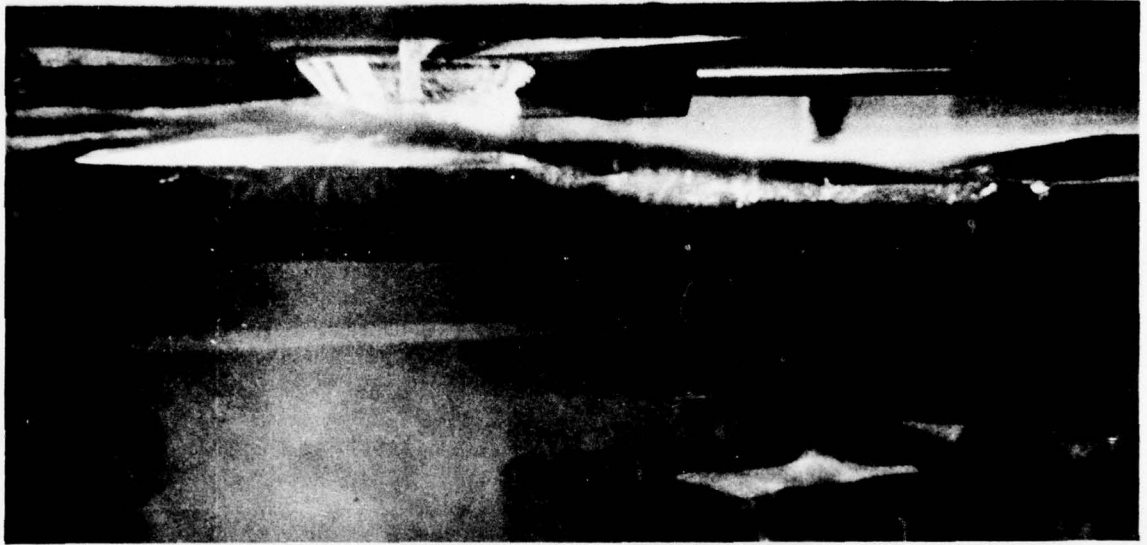


Figure E-7 - Model Ready for Testing





Model Being Tested in a Reconstructed Sea.  
(Note the semi-submersible condition of the hull)

EDITOR'S NOTE

Midshipman Richner prepared this history of the Cape Hatteras Lighthouse in addition to his normal services of being the supply and physical officer for the project. No project could be successful without the likes of him and his help and friendship will always be remembered by those who know him.

PRECEDING PAGE, BLANK, NOT FILMED

A HISTORY OF THE CAPE HATTERAS LIGHT HOUSE

by

Charles Richner

from

A report for the Division of History,  
Office of Archeology and Historic Preservation,  
U.S. Department of the Interior

by

F. Ross Holland, Jr.

## The Need for the Cape Hatteras Light Station

Ever since the Spaniards started making regular trips to the Americas, sailors have tried to use the currents off our east coast to their advantage. Because of this, knowledge of the Gulf Stream was gained early.

This predictable current allowed the Spanish treasure ships to sail from the Carribean north along the coast in water that traveled as fast as four knots, a phenomena which helped shorten their voyages.

As the seas became more extensively explored it was found that there was a colder current that traveled along the North American shore in a southerly direction, the Labrador Current. Soon ships started making use of this two lane highway.

These two currents meet at Cape Hatteras and cause its constantly shifting shoals. The Gulf Stream pushes towards the coast, the Cape pushes out from the coast and the two leave only a few miles for the colder southerly found current to squeeze through. For ships headed south, getting by the Cape was a dangerous test of the imprecise art of navigation. A few miles east and they were fighting the Gulf Stream, a few miles to the west and they would be upon the shoals. The difficulties were compounded by unpredictable and savage sea characteristics of the Hatteras area caused by the two colliding currents. One moment it

could be an amiable day and the next the wind would come up and the ship would have to battle 15 foot seas. Navigation at that time depended heavily on land marks, for visual sightings and the low coast of the Outer Banks of North Carolina was of little help. It was composed of strips of sand lying well off the actual coast line and ships had to travel very close to this to get any dependable sightings.

The colonial era of the United States and early years of the Federal Government were filled with enough problems that it was not until the end of the 18th century that it was decided to build a navigational aid in that area. The threat that had to be avoided was the Diamond Shoals, but the closest feasible location for construction was the outward tip of Cape Hatteras. Many methods have been tried since then to get a visible and reliable reference point for mariners, everything from buoys to light ships. In this procession of trial and error was included the "old Cape Hatteras Light House," the light house that provided the last navigational position check before the Monitor went down. It is with the history of the old light house that this report shall be concerned.

#### CAPE HATTERAS LIGHT STATION

Congressional approval of funds for the Station were the result of a study done by the Treasury Dept. on a request to have

a light house built at Ocracoke Inlet. The whole North Carolina coast was studied and the opinions of the captains who used the area were listened to. Commissioner of Revenue Tench Coxe evaluated the report and came to the conclusion that a light on Cape Hatteras would be beneficial to a greater number of people. He recommended to Secretary of the Treasury Alexander Hamilton that only a beacon be placed at the Ocracoke Inlet and that the light house be placed on the Cape.

Congress authorized the construction of the two structures in April of 1794 but it was almost ten years before the light house on Cape Hatteras was built.

The greatest problem for the government was finding a bidder to construct the light house. Henry Dearborn of Massachusetts was the contractor who finally agreed to build the Hatteras and Shell Castle Light houses. The contract was signed on October 31, 1798 by Dearborn and on February 14, 1799 by a Federal representative.

Dearborn had already started work on the two light houses and despite some delays the Shell Castle house was nearly completed and the keepers quarters at Hatteras were built by the summer of 1800. This is when Dearborn's problems got serious. His workmen became sick and one died and he was forced to stop work and send the men home again until they were well.

When Dearborn's men started again in the spring of 1801,

the government had paid \$30,200 of the \$38,450 contract even though work was far from complete on the Hatteras station. The work crews stayed only until early fall, when it is thought they were again hit by sickness.

Work continued in this piecemeal fashion. The Hatteras light house was reported as ready for lighting in August of 1802 but for reasons that are now unknown, they were not immediately lighted. It is not known exactly when the lighting occurred, but the station was in operation by October of 1803.

#### LIGHT HOUSE KEEPERS

As the station neared completion the government started looking for a qualified keeper. Dearborn recommended Thomas Farrow but one of the commissioners of the department had another man in mind. This man, Adam Gaskin, had been recommended by a North Carolina congressman when the construction of the station had first been authorized. Gaskin must have been a satisfactory keeper, because there are no records of any problems relating to him. He filled this position until 1808 when Joseph Farrow became the keeper.

All went well until 1818 when complaints started coming in from ship captains that the light was not reliable. The first incident was blamed on poor quality oil but subsequent complaints initiated the replacement of the keeper. The new

keeper Pharoah Farrow took over in April of 1821 and at the same time the supervisory duties for the area were shifted to a Federal employee who was closer to the station and could get feedback more easily from mariners.

Complaints started reaching the newspapers in 1829 about the poor quality of the Hatteras light. When investigated it was found that Farrow did not live at the station. He had hired several blacks to tend the light. He was removed as soon as this arrangement was brought to the attention of his superiors. A new keeper, Isaac Farrow was appointed in 1830.

The problems experienced by the supervisors with the rest of the keepers in the old tower were quite similar to those mentioned before. It is enough to say that few stayed more than three years and over half of the subsequent keepers were removed from their position.

#### TECHNICAL IMPROVEMENTS

The light houses of the 1800's were lighted by whale oil. When the Hatteras light was first put in use it was decided that experiments with propoise oil would be conducted. The primary experiments went well but later trials did not and porpoise oil was recommended as an emergency substitute only.

One of the problems that plagued the station its entire existence was erosion. The keepers were constantly filling

in the sand around the base of the tower just as the wind was constantly blowing it away. Many half measures and repairs were undertaken but the problem was never permanently solved. The most reasonable suggestion on this matter was that the area around the tower be paved with tar or brick. The only preventative action that was ever taken was the construction of a board fence three feet high at a distance of four feet from the base of the tower, with bushes planted between the fence and the tower. This must have been only partially effective because complaints about erosion are mentioned periodically in later accounts.

The most serious problems that the station had all related to the light itself. The first oil cisterns were not large enough so new larger ones were dug. Often a particularly violent storm would break the glass in the lantern and the light would be only partially operational, if at all, for weeks afterward. Another frequent occurrence was that of fires caused by the light. Usually these fires resulted in the breakage of vital glass apparatus.

In 1815 the government decided to upgrade the technical aspects of their lighthouses. They contracted Winslow Lewis of Boston to replace the lights in all the nations light houses with a combination of an Argand lamp, a parabolic reflector, and a lens. The Argand lamp was unique in that its wick was hollow and allowed air to flow through the center making

a more uniform and intense flame. The "parabolic" reflector was little more than a poorly curved reflector and the lens actually decreased the effectiveness of the light. The lenses were later removed. These improvements did decrease oil consumption and also resulted in a better light.

Another interesting fact is that the tower, which was intended to be a day marker also, was never whitewashed nor was it painted until very late in its life time. This was a good example of how little the keepers and supervisors understood the reason for their jobs.

In June of 1835 an inspection showed that the station was in bad need of repair. The lantern was badly rusted and needed to be replaced, as did the window sills around the entire top of the tower. The lantern was replaced in 1835 but the station had acquired a reputation for being unreliable.

During the next ten years there were a large amount of repairs made and finally the lanterns were again replaced. The one positive result from this was that the light was visible thirty miles at sea.

The operation of the light station continued in a more or less reliable manner for five years. The next problem that was brought to the attention of the government was that the light was often obscured by ground fog. The Navy's Chief Engineer, Benjamin Isherwood, was sent to study the problem. His report stated that a mist was caused by the Gulf Stream

and that it stayed about 100 feet off the ground. If the light were lowered, he stated that the light would be below the haze but that it would not be visible far enough to sea to protect mariners from the Diamond Shoals. His conclusion was that the problem could not be solved until a light that could penetrate the fog was found.

Although the keepers and supervisors seemed to be doing all in their power to provide a quality landmark, it is evident from the following comments of naval officers that they were failing.

Lieutenant David Porter wrote this about the light:

". . . I always had so little confidence in (the Cape Hatteras light) that I have been guided by the lead, without the use of which, in fact, no vessel should pass Hatteras. The first nine trips I made I never saw Hatteras light at all, though frequently passing in sight of the breakers; and when I did see it, I could not tell it from a steamer's light, excepting that the steamer's lights are much brighter. It has improved much latterly, but it is still a wretched light."

Another Lieutenant, H. G. Harstene, USN, was more succinct in his evaluation of the light: "The light on Hatteras . . ., if not improved, had better be dispensed with, as the navigator is apt to run ashore looking for them."

The Hatteras Station had been under the scrutiny of the recently formed Lighthouse Board for some time. Their recom-

mendation was that a Fresnel lens be installed and that the focal plane of the light be raised. Congress acted on this recommendation and the necessary funds were appropriated. When the work was finished the light had been enlarged from approximately 100 feet to a level of 150 feet, the Fresnel lens had been installed and for the first time the tower was painted as a day mark, whitewashed for the first 70 feet and painted red the rest of the way to the top. The only other major repair done to the old Hatteras light house was as the installation of a new improved lens in 1863.

The final problem encountered in the maintenance of the Hatteras station, a very serious one for the entire country, was the Civil War. When North Carolina seceded from the Union on May 20, 1861 troops from the state government stopped the operation of the station. Since the Confederacy had a very small navy, and blockade running was their main interest, it was to their advantage to remove navigational aids.

By August 1861, Federal troops had retaken the Hatteras station and work was begun to relight the lamp. As this task was undertaken, reports were received that the tower itself was in poor condition. Temporary repairs were made and the light operated normally until it was replaced by a new structure. Funds were approved for the new light house tower in 1867 and work began on a site 600 feet northeast of the old tower in 1868.

The end of the old tower came on February 16, 1871 when it was razed by placing three mines in the beach side of the base and exploding them.

#### DESCRIPTION OF CAPE HATTERAS LIGHT STATION IN 1858

##### Cape Hatteras Light Station

Name: Cape Hatteras

Number of Lights: One

Location: North of extremity of the Point of the Cape about 2 miles.

##### Tower

Color: White and Red

Materials: Stone and Brick

Height from base to coping: 118 feet

Thickness of Walls at base: 5 1/2 feet

Size of each pane: 10 x 12 & 8 x 10

Staircase materials: Wood

Number of air tight oil butts: (six old pattern, not air tight)

Thickness of Walls at top: 2 1/2 feet

Interior Diameter at base: 15 feet

Interior Diameter at top: 12 feet

Number of windows: 11

##### Keepers' House and Grounds

Number of Houses: One dwelling & one smoke house

Color: White

Materials: Wood

Roof-material: Shingle

Color: Has been red, all washed off

Horizontal Dimensions: 48 x 20

Number of stories: 2

Number of rooms: 6

Use of rooms: Keepers & families

Lantern

Painted or otherwise: Whitewashed and painted

Wells: One

House fixtures: Pendulum clock

Grounds, area of: 47 acres

Cultivated or not: Not, mostly covered with water

Number of boats: 9

Illuminating Apparatus

Order: 1st

Kind: Lens

Arc Illuminated: 360°

Color of Light: White

Characteristic: Flashing

Duration of flash: 6 seconds

Height above sea level: 165 feet

Lantern

Materials: Iron

Interior Diameter: 12 feet

Height glazed: 9 or 10 feet

Number of sides in plan: Circular

Number of panes in side: 96

Size of panes: 37 x 27 irregular

Floor material: Iron

Arrangement for closing glass inside and out: Good

Lamps

Kind: Mechanical

Number: 3

EDITOR'S NOTE

The episodes leading up to the final search for Monitor began in the fall of 1973 as the results from the Duke-National Geographic expedition were being studied and the midshipmen were busy researching their subject and giving briefings on their findings within the Navy Community.

Dr. Harold Edgerton of MIT was instrumental at this stage to obtain a commitment from the U.S. Navy via Dr. D. S. Potter, Undersecretary of the Navy.

The Navy had scheduled the at-sea evaluation of the Alcoa Marine Seaprobe for undersea search and inspection in the spring of 1974. This seemed to be an ideal opportunity to utilize this unique ship in a limited search for the Monitor.

DEPARTMENT OF THE NAVY  
HEADQUARTERS NAVAL MATERIAL COMMAND  
WASHINGTON, D. C. 20360

03T/DLK

13 NOV 1973

MEMORANDUM FOR ADMIRAL I. C. KIDD, JR.

Subj: USS Monitor

Purpose: To provide a status report on Monitor search efforts and Navy participation to date.

Background: Over the past several years there has been a resurgence of interest in locating the wreckage of the Monitor. Among the interested are:

- a. Squid, Inc., President - R. R. Wommack,
- b. USS Monitor Foundation,
- c. Underwater Archaeology Associates, Inc. of Richmond, Va.
- d. North Carolina Tidewater Services, Inc.,
- e. A group (including Dr. Edgerton) supported by NSF, state of North Carolina, National Geographic and U. S. Army Reserve, and
- f. Naval Academy - staff and midshipmen.

None of these groups have much money, each has a different wreck site in mind and all have been trying to get Navy help. To date the Navy (Oceanographer) has provided navigation equipment and personnel support to Wommack, flown MAD surveys for the Naval Academy and agreed (Dr. Potter) to support the Edgerton Group to a maximum of \$40K.

Status: Of efforts to date, the Edgerton Group appears to be the most active and successful. The attached sketch was made up from 1973 photographic and video tape coverage of a wreck some 15 miles South - Southwest of Diamond Shoal Tower in about 200 feet of water. Evidence tying the wreck to Monitor:

- a. Location agrees with probable position taken from log of Rhode Island, which had Monitor in tow,
- b. General characteristics similar,
- c. Dimensions similar, and

Subj: USS Monitor

d. Nothing observed conflicts with it being of 19th Century origin.

I have seen the tapes and think the chances better than even that the wreckage is Monitor. If it is, there's a good chance that historically interesting artifacts can be recovered but no chance that the wreck itself can be recovered intact.

Dr. Potter has told Dr. Edgerton that he would support an expedition using the Alcoa Sea Probe with up to \$40K of Navy money. Presumably the source would be 6.3 Oceanographic Program funds funneled through NAVSHIPS (Supervisor of Salvage). Funneling Navy support through SUPSAL and treating as small scale test of Navy capability to search, locate and recover discrete objects is valid and worthwhile. The fact that the wreck is Monitor complicates it some, but, on the other hand we may be able to learn something from Edgerton and Company. Tentative plan calls for use of Sea Probe in April or May when she will be in the vicinity for other reasons.

#### Problems

- a. Within the Navy no one office is in charge of all the pieces,
- b. Support of one group and not another leaves Navy open to criticism by the have nots,
- c. Legal aspects unknown, and
- d. Vice Admiral Hooper (Navy Historian) has not been kept informed and probably because of this, project does not have his support.

#### Recommendations

- a. Put NAVSHIPS (00C) in charge of NAVMAT's participation including keeping all concerned informed, determining legal constraints, etc., and
- b. Support the Edgerton effort to a maximum Navy input of \$40K, if requested by ASN(R&D).

Very respectfully

(Signed) D. L. KEACH

Deputy Director of Laboratory  
Programs

EDITOR'S NOTE

Commander Colin M. Jones, Officer-in-charge of the Navy Experimental Diving Unit located at the Washington Navy Yard, Washington, D. C. was designated as the responsible officer for organizing and conducting the search. He thought it best to consult all available sources of information and to this end called a meeting to be held 11 March 1974 at the Naval Research Laboratory. All who had conducted searches or who were knowledgeable of the sinking were invited to attend and to present a twenty minute briefing on their finds. Only in this manner was it felt that the best use of the expedition could be obtained and also prevent any criticism of the Navy decision as participation in the Seaprobe expedition was based upon the evidence or information presented at the 11 March meeting.

Unfortunately, at this time, a misunderstanding began between John Newton of Duke University and Commander Jones as evidenced by some of the later criticism on how the operation was conducted. Selected entries are inserted to present a fair view of the actual occurrences and the decisions that were made. The first letter dated 21 February crossed in the mail with the explanatory letter from Commander Jones dated 22 February.

Duke University Marine Laboratory  
Beaufort, North Carolina 28516

February 21, 1974

Cdr. Colin M. Jones  
Office-In-Charge  
Navy Experimental Diving Unit  
Building 214  
Washington Navy Yard  
Washington, D. C. 20374

Dear Colin:

Recently, Dr. Edgerton, Mr. Watts and I have discussed a possible cruise plan involving ALCOA SEAPROBE and U. S. Army Reserve vessels. In an effort to economize as much as possible on expensive SEAPROBE shiptime, we propose to use the Army Reserve vessels in the preliminary work and logistics.

- 1) Ship side-scan sonar and Del Norte equipment to Beaufort, N. C.
- 2) Embark skeleton scientific party on LCU and J Boat for trip to Hatteras.
- 3) Install and check out Del Norte transponders on Hatteras Light and Diamond Shoals tower using J Boat.
- 4) Locate wreck site #2 from LCU using side-scan and Del Norte plus radar ranges and visual bearings.
- 5) Plant lighted buoys on or near site.
- 6) LCU and J Boat return to Beaufort.
- 7) Transport people and equipment to port of embarkation by air or land vehicle(s).
- 8) Embark on ALCOA SEAPROBE.
- 9) Check out of equipment and familiarization with SEAPROBE capability while enroute to Hatteras.
- 10) Station SEAPROBE over site #2, complete videotaping of wreck and surrounding debris. Recovery of EG&G camera and pinger. Recovery of artifacts.
- 11) SEAPROBE rendezvous with LCU and J Boat to offload equipment and artifacts, or if weather is inclement SEAPROBE, LCU and J Boat to Morehead City Port Terminal for offloading equipment and artifacts.

February 21, 1974

- 12) SEAPROBE departs for next destination. LCU departs for Kure Beach, North Carolina with artifacts.

Obviously, the artifacts will require special attention immediately upon recovery. A team of archaeologists and preservationists will go through an elaborate description, preservation and packaging procedure for each artifact as it is recovered. It will be very important for every participant to assist Mr. Watts in this process of preservation and transport of material from wreck site #2 to the State Archaeological Laboratory in Kure Beach, North Carolina. The LCU should prove to be a valuable logistics tool for this purpose.

We are very concerned about maintaining the function of this excellent team of engineers, navigation specialists, archaeologists, historians and preservationists which was assembled for last summer's expedition. For this reason it is very important for seventeen berths to be reserved aboard ALCOA SEAPROBE in order to accommodate the team during the work on wreck site #2. If other projects are scheduled for this voyage of SEAPROBE, arrangements can be made to transport personnel through Hatteras Inlet or to change scientific parties at the Morehead City Port Terminal on completion of our work. All participants in the expedition (including the vessel crews) should sign literary releases to ensure preservation of the National Geographic Society's rights to popular publication of this story.

Enclosed is a list of items which we would like to see included in the agenda for the meeting on or about March eleventh.

Thanks very much for your efforts in coordinating this work.

With warmest regards,

(signed) John

John G. Newton  
Marine Superintendent  
Oceanographic Program

JGN:dj

Enclosures

cc: Dr. H. E. Edgerton  
Mr. G. P. Watts

SUGGESTED AGENDA ITEMS FOR MEETING CONCERNING SALVAGING  
ARTIFACTS FROM THE WRECK OF USS MONITOR

- I. Rational for use of ALCOA SEAPROBE
  - A. Officially sanctioned State of North Carolina, Division of Archives and History Project.
  - B. Support provided by State of North Carolina, Navy, National Science Foundation and National Geographic Society.
- II. Review of Evidence
  - A. Historical Summary
  - B. Sonar Records
  - C. Photographs and Videotapes
- III. Cruise Plan
  - A. Scheduling
  - B. Sequence of Projects on SEAPROBE voyage
  - C. Logistics and Personnel Transfers
  - D. Communications
- IV. Team Effort at Wreck Site #2
  - A. Need for seventeen berths in scientific party aboard SEAPROBE
  - B. Equipment to be employed
  - C. Ship and equipment capabilities and limitations
- V. Preserving Confidentiality
  - A. National Geographic Society's Literary Rights
  - B. Protecting this historic site from exploiters
  - C. Preventing amateur diving accidents.
- VI. Allocating Costs
  - A. Navy
  - B. National Geographic Society

NAVY EXPERIMENTAL DIVING UNIT  
BLDG. 214, WASHINGTON NAVY YARD  
WASHINGTON, D. C. 20374

EDU:CMJ:jt  
4740  
Ser: 88  
22 FEB 1974

From: Officer in Charge, Navy Experimental Diving Unit  
To: Distribution List

Subj: USS Monitor

1. Background. There has been considerable interest in recent years in finding the Monitor. Significant time and resources toward establishing the location of the Monitor have been expended by several groups and individuals. Several groups have approached various U. S. Navy agencies requesting assistance in furthering their search efforts. Thus far little Navy assistance has been available.
2. NAVSHIPS(OOC) has been designated as the NAVAL MATERIAL COMMAND representative regarding the Monitor search. CDR Colin M. Jones, USN is designated as the responsible officer.
3. The U. S. Navy plans to expend a limited amount of funds in an attempt to verify one or more probable Monitor sites. At present \$40K of Navy search effort by the ALCOA Sea Probe is planned. These funds are for the purpose of demonstrating the capabilities of Sea Probe to function in such a search and verification mission. \$20K has been authorized by National Geographic. Approximately \$40K in additional funds are probably needed to mount the sort of search effort that would be the most effective. If additional funds are made available from some source, they will be used. If not, whatever search effort that can be conducted within the funding constraints is planned.
4. In order to realize the maximum gain from the funds expended, it appears logical to gather the best information available from all sources as to the probable location of Monitor. Once this information is assembled, the possible search site or sites will be determined, based on information made available, and a priority established for each site. The actual search will then be conducted based on this priority list until funds available are expended.
5. Addressees are invited to participate in a meeting to be held 0800 11 March 1974 in the auditorium, Bldg 28, Naval Research Laboratory, Washington, D.C. Report to visitor control, Bldg 72 upon arrival. The purpose will be to provide

Subj: USS Monitor

each addressee an opportunity to present a 20 minute brief of his information concerning the Monitor location. This brief should contain factual information on location, Navigation systems used, and evidence found to support the belief it is the Monitor. This information will be a major factor in determining the relative priorities of the sites to be surveyed. In addition each addressee should be prepared to present any conclusive evidence which identifies any other wrecks in the general area as being positively not the Monitor, which would be of value in weighing information provided by other participants.

6. Addressees are requested to confirm by phone call to CDR Colin Jones, phone Area Code 202 433-3007 that they will be present and will have a presentation to make. Copy to addressees who desire to make a formal presentation should also contact CDR Jones.

(Signed) Colin Jones

Distribution List:

Dr. Harold E. Edgerton  
Mr. Michael J. O'Leary  
Midn 1/C Edward M. Miller  
Mr. E. A. Wardwell  
Mr. Roland R. Wommack  
Mr. Gordon P. Watts

Copy to:

Mr. F. Worth Hobbs  
CAPT W. F. Searle, USN (Ret)  
Mr. John G. Newton  
Mr. Edwin W. Snider  
Dr. Stephen J. Gluckman  
VADM Edwin B. Hooper, USN (Ret)  
Mr. James S. Hutchins  
CAPT E. Clausner, USN  
CDR John E. McNish, USN  
CAPT D. L. Keach, USN  
CAPT Philip Johnson, USN  
CAPT J. H. Boyd, USN  
CAPT J. T. Geary, USN  
CAPT C. E. Lundin  
Mr. Ernest Peterkin  
Mr. Joseph D. Libbey, Jr.

EDITOR'S NOTE

The meeting scheduled for 11 March suddenly became an arena of immense interest as it was preceded by the announcement of Duke University/State of North Carolina on 8 March that they had sufficient evidence that they had found the Monitor. This resulted in nation-wide news coverage and considerable attention to be given to the Seaprobe expedition.

The first entry is the presentation which the editor presented at the NRL meeting, followed by the summary of the second airborne survey conducted by Project Cheesebox on 17 January 1974 of a search area designated by the historical account of sinking. The last entry is a summary of the meeting by Mr. Chester Buchanan of the Naval Research Laboratory, a well recognized expert in underwater search and photography.

Captain Geary

Commander Jones

Ladies and Gentlemen

I have been asked to deliver a presentation on Project Cheesebox, which is being conducted under the auspices of the History Department at the U. S. Naval Academy in Annapolis, Maryland.

Let me begin by explaining our title. The U. S. Ironclad Monitor earned several descriptive nick names during its short career, such as Tin Can on a Shingle, Ericsson's Folly, and Cheesebox on a Raft. Hence we coined Project Cheesebox as a suitable heading.

Our project had humble beginnings in February of 1973, when the Monitor became the subject of a conversation between Midshipman, now Ensign Michael Ellison and myself. I had read Mr. Robert Marx's book Always Another Adventure while on cruise the previous summer and had entertained the thought of further inquiry into the subject.

Doing very cursory research at our library at the Academy we found a big discrepancy between the official reports and Mr. Marx's claim that the Monitor lay a mile north of the light house in 40 feet of water. Desiring to investigate this further,

we found our way into the office of Mr. William Andahazy of the Naval Ship Research and Development Center in Annapolis. He is a physicist, specializing in magnetic detection and analysis. With his generous support we made plans for a May field trip to the Hatteras area with the idea of deploying a small craft to conduct a surface search of the area claimed by Marx. We were unable to do so because of environmental conditions.

After Ensign Ellison's graduation and during our leave period we continued to look at the problem. Mr. Andahazy continued his support and made contact with Mr. George R. Lorentzen of the Airborne Branch of the Magnetism Division of the Naval Oceanographic Office. With his assistance we were able to accompany geophysicists on a Project Magnet flight that was scheduled for that area. Project Magnet is a Navy sponsored world wide magnetic survey. They became interested in the capability of accurately fixing a stationary magnetic target in a relatively small ocean area. This flight was very successful.

Realizing that finding the hulk is only a small part of any serious research effort, we spent the rest of the summer organizing our research outline and objectives and discussing

our project with people in the field.

Returning to the Academy in the fall, I discussed our proposal with Professor William M. Darden of the History Department and with his encouragement we presented it to Dr. Richard Mathieu, the Director of Research. Under their direction we have formalized Project Cheesebox

Project Cheesebox is an integrated history project in the sense that it involves multi-disciplined research. There are participating midshipmen from the History, Engineering, Oceanography, and Ocean-Engineering Departments. Our objective is to study the Monitor in its entirety, by using modern scientific techniques to solve an historical problem.

In broad terms, our historical review entails a study of the conception, the construction and service history of the vessel.

In general, there are two major historical themes involved with the Story of the Monitor.

Primarily, it is a story of a struggling Union engulfed in Civil War, whose strategy for victory depended upon the successful blockade of Southern ports. The South, not having a Navy resorted to the construction of a radical new warship. Rumors of its construction and the probable destruction of

Northern cities grew to panic proportions. The North had to have an ironclad to meet this new threat, as Great Britain and France were carefully watching the turn of events. What did the North do, why it advertised in the New York Times, of course and established an Ironclad Board composed of Senior Naval Officers who had little faith in steam engineering, let alone a ship built of iron.

This brings us to the second major theme running through this history - the story of a Swedish immigrant who steadfastly believed in himself, when all others doubted and made him the subject of public ridicule.

John Ericsson was an exceptional individual. He used drawing instruments when he was nine, and helped design a dam in his native Sweden at 15.

To this day there exists a controversy concerning the origin of the revolving turret, the Monitor concept. We have addressed ourselves to this question and have asked midshipmen at the Swedish and French Naval Academies to assist us. From the McCord Collection of Ericsson's original engineering drawings at Steven's Institute of Technology we have found a design for a human propelled gunboat possessing similar characteristics to the Monitor dated in the 1840's. It is a point

of history that Ericsson proposed his concept to Napoleon III in 1854. From that time until 1861 it was left on the shelf.

It was only by chance circumstance that Ericsson consented to submit his design. After having been blamed for the explosion of an experimental gun which killed an Assistant Secretary of the Navy on board our first screw propelled warship, the Princeton, Ericsson swore never to deal with Washington or the Navy Department again.

Only through the persuasion of a personal friend and President Lincoln himself, was Ericsson swayed to present his design to the Ironclad Board. Even after the contract was awarded, the experts continued to doubt, along with the public which called it Ericsson's Folly. Under the terms of the contract, he was to provide his warship with spars and rigging and he was not to be paid until it was proven in battle.

Up to the day of the launching, Ericsson was confident in his mathematical calculations and proved it by standing steadfast on the deck as she slid down the ways, and to the amazement of all who watched, floated exactly along his calculated water line.

Popular history tells us that the Monitor was constructed in 100 days and that Ericsson drew the necessary over 3,000

engineering drawings at night while supervising the construction during the day. We have found drawings of Ericsson's which significantly pre-date the contract date, therefore giving evidence that the design was well thought out in detail prior to the commencement of construction.

We have thoroughly researched the construction of the Monitor and we are building an exploding model of the ship displaying both exterior and interior details.

This has a two fold purpose. First to assist us in evaluating the design and method of construction and second to evaluate the warship as a system's platform. This involves a detailed study of the steam engineering plant which possessed many distinctive features characteristically Ericsson's and a study of the weapons system - the turret.

We are asking ourselves, how good was the design? What were the Defects and were they critical?

In conjunction with this we are constructing a tow tank model to test the design characteristics in various sea-states, trying to evaluate it as a weapons platform and to determine its seagoing capability. In addition we are conducting a progressive flooding test to measure this effect.

We will compare our exploding model to an already existing

half-model in the Naval Academy Museum, built by an engineer on board the vessel which will be added to that model's documentation.

We are developing a day-by day chronology of the commissioned service of the warship modeled after the Civil War Naval Chronology published by the Naval History Division.

We have written a narrative of the events leading to the sinking using 19 original sources from personal correspondence, official reports, and newspaper and magazine accounts of the day. Using over 700 computer cards we have developed with the great assistance of Mr. Peterkin, a common narrative which integrates all the separate accounts and reveals, we feel, the complete story of that stormy December night. This has greatly assisted in the refinement of the historical track as Mr. Peterkin has explained. But more important than the location of a cold, rusty, iron hulk, it tells the story of the men who fought her against an adversary from which her heavy iron was no defense. This was what made history.

The final and focal point of our project is the development of search techniques. Mr. Andahazy will explain the theory and methodology of conducting an airborne magnetic survey in detail. Briefly, in the field of deep ocean search,

perhaps the most difficult phase is the localization of the search area. Given a large ocean area to search, for a ferromagnetic target, the fastest method to locate positions to be investigated by a suitable surface ship, is by air. The search techniques developed under the direction of Mr. Andahazy have demonstrated the capability of the equipment and the operators to conduct such a survey with consistency and accuracy. The theory behind such an approach is a major contribution to the field of magnetic analysis.

Technological Considerations in the  
Location of the USS Monitor

## Background

The Naval Ship Research and Development Center (NSRDC) has been assisting Project Cheesebox since its inception by the Midshipmen of the Naval Academy. Foremost, was the development of search techniques to localize the wreck and to explore methods of conducting survey operations. Additionally the Laboratory provided model basin facilities for an analysis reconstructing the Monitor under tow by the Rhode Island on its fateful voyage. This segment of the paper will be directed towards the project efforts to locate and identify her.

Based on historical evidence that the wreck was somewhere within several hundred square miles off the Hatteras Coast and considering the strong possibility that the Monitor may have been buried over the years on the sea floor, methods of Magnetic Anomaly Detection, commonly termed MAD, were considered as most practical for localization and identification. The rationale for employing this technique being:

The magnetic field or signature of the ship is unaffected or unaltered by the natural surrounding media, whether it be sand, sea water or bottom sediment.

The MAD range is relatively large. Consequently, broad areas can be surveyed swiftly, through the use of an aircraft on which MAD equipment has been installed.

The large magnetic moment expected due to the iron content and its state of equilibrium magnetization make it an easy target, especially in shallow water.

Some problems, however, can occur in differentiating between multiple magnetic and false contacts obtained in the search area due to high geologic noise in the Cape Hatteras area. These signals were "weeded out" by a mathematical analysis which provided a basis for pattern recognition and the design of a suitable flight plan.

#### Magnetic Air Search Consideration

Briefly, the target lying on the sea floor will exhibit a plane of detectable magnetic disturbance coincident with the search plane of the magnetometer. The parallel flight paths of the aircraft were designed to provide an overlap of search width. Hence, if the aircraft is capable of maintaining its position of heading while traversing a flight path, detections should result on at least two successive flight tracks. Computation of the theoretical perturbation area was based upon the use of a scalar magnetometer having a least recognizable signal of 0.2 gamma (1 gamma =  $10^{-5}$  gauss) in a 0.1 gamma fluctuating ambient.

Aircraft track separation can also be adjusted on the basis of position accuracy and a probability of detection factor. Further, trade offs must be evaluated for a desired area coverage versus aircraft availability, that is, by reducing overlap in order to obtain wider area coverage, a decrease in the probability of detection will result.

The particular scalar magnetometer used in this search operation was the AN/ASQ-81 metastable helium magnetometer. This device represents "state-of-the-art" for airborne magnetic surveys. Operation of this magnetometer is based on the absorption properties of a helium sample when subjected to optical pumping and RF radiation. Information about an ambient field is obtained through the use of Zeeman transitions to determine changes in the resonance frequency of the optically pumped sample. Thus, a frequency relationship directly proportional to the total magnetic field is provided.

Any magnetic contact or measurement obtained by the scalar magnetometer is the vector sum of the ambient or surrounding field of all contributors and that of the ferromagnetic target. Consequently, any magnetic modeling for the purpose of measurement matching must account for this vector addition.

#### Magnetic Surface Search Consideration

Once target localization are acquired by the airborne survey, individual inspection of promising anomalies was planned. In order to corroborate the magnetic contacts obtained in the air with a target on (or under) the sea floor, a dual search mode i. e., active sonar and magnetics was explored, the purpose of this activity was to further validate the airborne positions by sonargram and magnetic field and gradient analysis in the absence of diver support or subsurface

video capability. Also, if no contact was obtained by sonar, indicating a possible burial, surface borne magnetometers would surely furnish information toward the whereabouts of the target. This prompted a second magnetic analysis to calculate the total near field and magnetic gradients expected from the Monitor at various sea depths. This analysis required magnetic permeability studies to be conducted on similar antique wrought iron specimens from another ironclad, the USS Tecumseh. Figure 1 shows these ring specimens before and after coil wrapping, a technique necessary for B-H curve determination. The value of magnetic permeability was utilized in the mathematical computation of the near magnetic fields.

#### Mathematical Representation of Fields

Two methods of field calculations were utilized in this analysis. The first and simplest is a dipole approximation in which a magnetic anomaly at a point can be simply predicted from knowledge of a resultant magnetic moment and the range to the point. A method was employed which produced empirical relationships between the magnetic moment and ships displacement. Since the airborne measurements at the Closest Point of Approach (CPA) were expected to exceed three ship lengths, higher order terms of the field expressions were justifiably neglected and only dipole terms were considered. Using a modified version of a computer program developed at the laboratory, several matrices of data were calculated for the cardinal

and intercardinal heading of the Monitor at various separations from the search aircraft. The form of the general equation is as follows.

$$\vec{T}_F = \frac{\vec{M}}{r^3} (1 + \cos^2 \Theta)^{1/2} \cos \left[ \tan^{-1} \left( \frac{\tan \Theta}{2} \right) + \Theta + \beta \right]$$

where  $\vec{T}_F$  = magnetometer sensed total field.

$\vec{M}$  = resultant magnetic moment for the Monitor on any magnetic heading relative to the magnetic north vector at Cape Hatteras.

$\vec{M} = (\vec{m}_X^2 + \vec{m}_Y^2 + \vec{m}_Z^2)^{1/2}$ ;  $m_{X,Y,Z}$  are the component moments of the ship for any given heading.

= direction angles between the target and sensor.

A typical data matrix for this analysis is presented in Figure 2.

The second analysis performed was more complex and involved an analytic solution of a uniform body immersed in a uniform field. The essence of this computation for the near magnetic field involved a solution of Laplace's equation for an ellipsoidal shell; i. e., the generation of a magnetic scalar potential for this body. From this potential, both total field and first gaussian ( $\rightarrow \leftarrow$ ) magnetic field values were calculated for

$$\frac{\partial H_x}{\partial x}, \frac{\partial H_y}{\partial y} \quad \text{and} \quad \frac{\partial H_z}{\partial z}$$

where  $H_{X,Y,Z}$  are orthogonal component magnetic field values.

A two-inch shell thickness was used in the analysis to allow for thickness tapering toward the end points, since the ellipsoidal shell is represented by two ellipsoids which are

confocal. A typical data matrix for the near field gradient plane is shown in Figure 3.

Correspondence of sea surface gathered data to these matrices would have provided information regarding the general characteristics of the unknown target.

## RESULTS AND SUMMARY OF SEARCH EFFORTS

### Airborne Magnetic Survey

Assistance in magnetically surveying the areas of interest around the Cape Hatteras area was provided by the Naval Oceanographic Office, Chesapeake Beach, Maryland as part of Project Magnet, a world-wide aeromagnetic survey conducting geomagnetic investigations of ocean areas. Mr. George Lorentzen, Director of Airborne Magnetics, Naval Oceanographic Office supervised these surveys. The aircraft, an RP-3D operating out of VXN-8, Patuxent River, is equipped with an AN/ASQ-81 metastable helium magnetometer mounted in the tail boom of the aircraft. This installation is shown in Figure 4.

Position of the aircraft is maintained with LORAN C and SATNAV. All data is real time synchronized and recorded on magnetic tape for future analysis. Reduction of the data is performed by correlating any given signature to parallel tracks and fitting these curves to the model curves generated by the computer. Similar or nearly similar curves will determine a target position relative to some maxima or minima of data. However, precise timing to CPA is a relative unknown

when a single magnetometer is used; consequently, target position errors can be expected in addition to inherent error in the on-board navigation systems. This is understandable since the aircraft velocity can cause overshoot of the target unless the timing is near perfect. Therefore, establishing CPA as best as possible is imperative for accurate target acquisition.

As pointed out in earlier discussion, the general search area was determined historically by Mr. Ernest Peterkin and Ensign Edward Miller, USN. Their research proved invaluable in limiting the thousands of square miles which are final resting places for nearly as many sunken ships that line the outer banks of Hatteras.

During all flight operations fifteen different uncharted anomalies were recorded. Of these, only two reasonably fit the criteria set by the mathematical analysis. One of these locations coincided with a wreck site explored by a team of researchers from Duke University and thought to be the Monitor. Figure 5 is the magnetic recording obtained by the P-3 over this site.

The location of this wreck by the airborne system and mathematical model comparison was within 0.2 miles of its actual coordinates. This inaccuracy is partly attributed to our inability to adequately determine from the output trace, the point at which CPA actually occurs. Similar results were

also acquired on the Empire Gem, a charted wreck in the Monitor search area. It is important to note that validation of the Monitor site by the R/V Alcoa Seaprobe indicated the position of the wreck which is roughly east-west, closely agreed with the predicted heading made by comparison of the airborne magnetic signature and the mathematical computations.

Magnetic sea surface mapping as formerly described, of any suspected location obtained by the aircraft MAD system has not been conducted, since the good fortune of obtaining underwater visual equipment aboard the R/V Alcoa Seaprobe precluded trial of this scheme. And the further good fortune of finding the Monitor at the first wreck inspection terminated further serious search efforts.

#### SEA SURFACE SEARCH AND VERIFICATION BY R/V ALCOA SEAPROBE

As a measure on the part of the Navy to evaluate the R/V Alcoa Seaprobe in search and recovery operations, a program was initiated for the purpose of searching and finding a wreck on the sea floor, photographing it in detail and recovering some objects of interest.

The site selected for the evaluation was an area southwest of Cape Hatteras that had been surveyed by the Project Cheesebox team and also explored by Dr. Harold Edgerton of MIT and the Duke research team.

The Seaprobe is a 243 foot all aluminum research vessel

designed for deep-sea working operations. The ship provides a dynamically positioned working platform with the use of two Voith-Schneider diesel-electric cycloidal propeller units, one forward and the other aft, which provide a hovering capability over a target against ocean winds and currents. The vessel employs a semi-ridged pipe string through an open well deck in the ship's hull for the purpose of deploying an instrumented pod for search and identification operations or recovery systems for sampling studies and retrieval of objects from the sea floor. The drill pipe string can be lowered to depths of 18,000 feet and can recover objects weighing up to 200 tons from 6,000 feet. The instrument pod used on this operation carried side-scan sonar, target illuminating systems, television, 35mm cameras, and required telemetry.

Commander Colin M. Jones of the Navy Experimental Diving Unit in Washington, D. C., who was in charge of the operation, selected on the basis of available information a series of eleven locations to be investigated by the Seaprobe to test the ship's undersea search and identification capabilities.

The expedition got underway from Morehead City, North Carolina on 31 March. The evaluation team included members from the Naval Research Laboratory, the Naval Academy, Naval Research and Development Center, Duke University, the National Geographic Society, and the State of North Carolina. The ship arrived over the coordinates of the first site at 0800, 1 April

but it took six hours to refine the fix and position the Sea-probe over the wreck.

More than 1500 photographs and several video tapes were made of the wreck before stormy seas and turbid waters ended operations and prevented any attempt to recover artifacts. The study of these tapes and photographs enabled the Navy-Duke-North Carolina team definitely to identify the wreck as being the remains of the Monitor.

The hulk of the vessel is resting bottom-side up on the ocean floor in 210 feet of water. Roughly a fourth of the turret is visible protruding beyond the armor belt, as it must have sheared off the deck when the ship sank to the bottom. A photo mosaic of the hulk was assembled from the photographs and the following distinguishing characteristics were noted: (1) bow and stern shapes, (2) direction of the plating, (3) distinctive armor belt clearly visible, (4) peculiar diagonal braces used **in** the construction, (5) shape of skeg and extended propeller shaft position, (6) overall size of hull and general dimensions and (7) flat bottom. In addition, a portion of the underside of the turret was clearly visible and the thickness of the turret armor and turret dimensions were identical to specifications from original engineering drawings on loan from the Steven's Institute of Technology in Hoboken, New Jersey.

From the data collected, it is evident that the hulk is

in a fragile condition, with 112 years of submersion in salt water taking its toll. However, it was noticed that the armor belt, constructed of oak with iron plating, was in surprisingly good shape and that the turret, constructed entirely of iron, was still intact.

MEMORANDUM

8401-164:CLB:cw  
14 March 1974

To: Code 1000  
Via: 8400  
8000  
From: 8401

Subj: MONITOR Hulk, Recommendations Concerning

Encl: (1) MONITOR Search; Conference Report

1. Enclosure (1) is a brief resume of the meeting on MONITOR hulk related activities, held at NRL on Monday 11 March 1974. This memorandum contains the writer's comments and recommendations.

2. The information and documentation presented make a reasonably good case for the contention that the MONITOR has been located. These data are however inadequate for any other purposes (such as, a display for public viewing or for assessing the recoverability of the wreck.)

3. In view of the present plans to utilize the "Alcoa Seaprobe" to conduct operations in connection with the MONITOR hulk, the following guidelines are suggested:

a. No further search operations should be contemplated.

This recommendation is made on the following basis: The "Edgerton - Duke University" effort and magnetic surveys have generated at least ten (10) potential wreck sites with estimated location errors of  $\pm 0.1$  nm. It seems futile to conduct additional searches until detailed inspection of these potential targets is completed.

b. The first site to be investigated should be the Edgerton - Duke University hulk.

This recommendation is based primarily on the claims of the search data analysis presented in the meeting of 11 March. The effort which went into this analysis is quite extensive and cannot be duplicated since the video tape is deteriorating rapidly. It is very unlikely that the available data could be used to disprove the claim.

c. Additional investigative effort should be applied in the order of priority as listed in the magnetic survey analysis.

It should not be anticipated that absolute identification of any one hulk will be achieved at sea. The data must be subjected to considerable analysis and this expensive vessel should not be hampered by snap judgment changes in mission. The thrust should be for complete "hard copy" photographic documentation of each contact in sequence.

4. The following comments regarding equipment and vehicles are offered:

The Sea Probe does not seem to be the optimum vehicle since it cannot use a magnetometer and it must maneuver the whole ship to perform the inspection. A "CURVE" vehicle operated from an anchored ship would be a better choice. This does not mean that Sea Probe cannot perform the mission, however. Her fortuitous availability in this area probably outweighs the differences in capability.

It is regrettable that neither of these vehicles can easily utilize a magnetometer. It does not seem logical to conduct an investigation of magnetically located objects using systems which are unable to measure magnetic information.

5. The current efforts in this matter raise several interesting points of concern to the Navy:

a. The airborne magnetometer search method would be a useful technique in case of loss of a ship in shallow water. If however we have not previously surveyed such shallow water areas, there is no good way to determine the existence of a "new" target.

b. The technique used in rating the various magnetic anomalies cannot be validated unless the targets are identified.

c. There is a lack of information about the magnetic behavior of ancient ferromagnetic structures, i.e., should we expect the magnetic behavior of a structure to be invariant with age, or if not, what is the time dependence:

6. The data from the Sea Probe investigations should be subjected to detailed analysis by personnel with proper experience. This experience is highest at NRL and the NRTSC. Some means should be sought to utilize these resources. This arrangement should be arrived at before the Sea Probe investigations in order that appropriate information about the data collection can be obtained, and so that the notations and documentation system used is fully understood. (Note: The Sea Probe will not be in the CONUS area again for a long time.)

(Signed) C. L. Buchanan  
Associate Superintendent

CONFERENCE REPORT  
Monitor Search Pre-Planning Meeting  
11 March 1974

Background:

Duke University has located a wreck which it claims is the Monitor. Cdr. Jones (Head of Navy Diving School) has been assigned duty as coordinator of Navy activities and has \$40,000 for the purpose of advancing this cause. He plans to use the "Sea Probe" during April as it makes a transit from Ft. Lauderdale to Europe. It is only by the lucky chance that it must transit the Cape Hatteras area, that the \$40K can fund a week or so of time on station.

A preliminary meeting was held last Tuesday, March 5, to review the Naval Academy Project "Cheesebox." At this time Capt. Geary requested that I attend this meeting and make such recommendations as I see fit regarding appropriate effort, platforms etc.

Report of Meeting:

Cdr. Jones gave a short background statement.

Mr. Peterkin reported his "hobby" activity in reconstructing the ship's track from various logs and accounts. The Naval Academy study has turned up some new material but this does not greatly change the picture. The end result is an estimated position for the hulk of Monitor.

Midshipman Miller outlined "Project Cheesebox." This project involves an exhaustive examination of all documentation regarding the Monitor design, construction, naval employment and probable location. In addition models are under construction for use in flooding tests. Two sorties by "Project Magnet" aircraft have been flown to attempt to locate magnetic contacts in the area of probable loss.

Mr. Andahazy of NSRDC (Annapolis) gave an account of the magnetic search and analysis of the resulting data.

Mr. Wommack presented information about efforts known to him in connection with the Trident Foundation. The Trident Foundation attempts to bring together resources to focus on location and preservation of historic artifacts on the east coast. He sited a sonar search (UOL) by Jim Elwood in 1949 which had reportedly seen the Monitor.

Mr. O'Leary represented the "Monitor Foundation" which has chosen a role like the Trident Foundation but limited to the Monitor. He recited some searches north of Cape Hatteras.

Mr. Newton of Duke University claimed the discovery of Monitor. He turned the meeting over to Mr. Watts for data analysis.

Mr. Watts played a video tape recording of the Monitor site. This was a good example of the problems of television. The fact that the imagery was necessarily played back in the order it was taken is very poor. It would have been much wiser to make photographs and form a montage. Under the circumstances which included Mr. Watts' positive statement, about what we were seeing, it was impossible to be objective. One thing is certain: no one can refute his analysis without a considerable application of manpower. It may in fact be impossible since the recording has been played so many times that it is nearly useless.

Mr. Jones closed the meeting with a promise to make every effort to avoid damage to the site in the April operation of Sea Probe.

#### Conclusions:

Three activities have attempted to reconstruct the track of the Monitor to its sinking. All three obtained positions within three miles of that obtained by Peterkin.

The Duke surveys were designed to cover a rectangle parallel to the bottom contours, while the "Project Cheesebox" survey used a rectangle parallel to the longitude - latitude grid. The position of the Duke contact is in the extreme NE corner of both search areas. In fact it would have been out of the "Cheesebox" area if it had not been intentionally extended to include this point.

The Duke contact is certainly a wreck and could very well be Monitor. The imagery was, however, so poor that general acceptance is unlikely. Furthermore the imagery is of no value for estimating the condition of the wreck.

#### Enclosures:

Agenda - Monitor Search Pre-Planning Meeting.  
Listing Magnetic Target Areas.

(Signed) C. L. Buchanan

EDITOR'S NOTE

After the meeting at the Naval Research Laboratory, Commander Jones, Mr. Buchanan and Mr. Peterkin planned the Seaprobe expedition. Careful consideration was given to the information presented at the 11 March meeting and on that basis an operation plan was drawn up.

Perhaps the most difficult decision that had to be made was the list of personnel to be present on board the Seaprobe. Each member of the expedition had to have something to offer in way of expertise to the operation. In total there were only thirteen berths available, quite understandably many of those who deserved to be aboard were unable to be given berths due to this limitation.

NAVY EXPERIMENTAL DIVING UNIT  
BLDG. 214, WASHINGTON NAVY YARD  
WASHINGTON, D. C. 20374

EDU:CMJ:jt  
4740  
Ser: 122  
15 MAR 1974

## MEMORANDUM

From: Officer in Charge, Navy Experimental Diving Unit  
To: Commander, Naval Ship Systems Command (Code OOC)

Subj: Monitor Identification

Encl: (1) List of Personnel

1. A meeting was held at NRL on 11 March which enabled all known interested parties to present their finding regards the location of Monitor.
2. A further meeting on Friday 15 March will result in selecting a sequence of sites for further identification efforts by the ALCOA Sea Probe. This meeting will be a small working group of professionals consisting of Mr. Chester Buchanan, Mr. Ernest Peterkin and myself.
3. Present plans call for the Sea Probe to load personnel and equipment at Morehead City on 31 March, and sail 1 April for about one week of effort.
4. We-that is the ALCOA Sea Probe personnel and I, will make a basic go-no go decision on the 29th or 30th based on the present and forecast weather. After that we will be committed to pay for the Sea Probe regardless of weather.
5. We plan a round-the-clock effort.
6. There will be 13 berths available. At present I plan to fill them approximately as indicated in enclosure (1). This will be subject to some changes, but should remain essentially as shown. We will have some option to bring out additional people, but will have to off-load one for each we bring aboard. I want to hold this down-there will be plenty of advice after the fact available, especially if anything is done wrong. I see no way to avoid this, but plan to be as diplomatic as possible and to consult the experts to the maximum extent possible.
7. The major goals are:
  - a. Establish the capability of the Sea Probe to do the necessary identification of a wreck site.

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Subj: Monitor Identification

- b. Look at as many sites in the area of the Monitor sinking as possible and identify them.
  - c. If the Monitor is found, recover confirming artifacts under the specific guidance of the North Carolina Marine Archeology personnel and thoroughly photo, map and otherwise document the site.
  - d. At no time take undue risks with personnel or material.
  - e. Retain the originals of all underwater photographs. Make prints, etc. available to Duke, North Carolina, and National Geographic group as possible without interfering with the USN interests.
  - f. Upon completion, submit a report of the operation.
8. Efforts have been made and will continue to keep JAG and CHINFO fully appraised of all actions taken. A request for CHINFO participation in the Sea Probe Operation will be made.

(Signed) Colin M. Jones

List of Personnel

1. CDR. Jones NAVXDIVINGU
2. Mr. Peterkin NRL
3. Midshipman Miller l/c
4. Chester Buchanan
5. Andy Rechnitzer
6. CHINFO Representative
7. Photo Intel. Center
8. Watts
9. N. C. State Representative
10. Newton
11. Edgerton
12. Geographic
13. Geographic

7004-42:EWP:jch  
19 March 1974

MEMORANDUM

To: Code 7000  
From: Code 7004

Subj: Monitor Search Site Selection

Encl: (1) Navy Experimental Diving Unit ltr EDU:CMJ:jt,  
4740, Ser. 122 of 15 March 1974

1. CDR Jones, Officer in Charge, Navy Experimental Diving Unit visited the Laboratory on 15 March 1974 to discuss with C. Buchanan and E. W. Peterkin the selection and priority of target sites for the 1 April sailing of SEAPROBE.
2. Targets selected were the Duke site, several targets represented by the Project Magnet anomalies lying south of the Duke site, and one target in the southwest section of the Project Magnet search area.
3. The following action items were set forth:
  - a. CDR Jones asked Mr. Buchanan and Mr. Peterkin to participate in the SEAPROBE search effort.
  - b. Mr. Buchanan was asked to investigate the capability of SEAPROBE personnel and photographic equipment for providing rapid photo hard copy for mosaic assemblies to expedite site identification.
  - c. Mr. Peterkin will review Monitor drawings held at the USNA to assist in photo identification.

(Singed) E. W. Peterkin

The Navy will conduct an at-sea evaluation of the research vessel SEA PROBE off Cape Hatteras, N. C., from March 31-April 7, to test the ship's undersea inspection and documentation capabilities. The first tests will be conducted over the site claimed recently by Duke University to be the location of the wreck of the Civil War ship MONITOR.

Officer in charge of the expedition will be Commander Colin Jones, USN, head of the Navy's Experimental Diving Unit in Washington, D. C. The unit's mission includes evaluation of new equipment and techniques for ship salvage and rescue operations.

Also participating will be representatives of the Naval Research Laboratory, the U. S. Naval Academy, Duke University, Massachusetts Institute of Technology, National Geographic Society, and the State of North Carolina. The participants are qualified to assist in location and identification of the MONITOR or other wrecks to be observed.

After inspecting the Duke-located wreck, whether or not it can be confirmed as MONITOR, the search operation will proceed to other sites in the vicinity. Navy searchers have located 11 wrecks in the area by use of magnetic anomaly detection (MAD) equipment. Precision navigation, sonar, and photo equipment will be used for accurate charting, inspection, and possible identification of the

wrecks. The sites will be inspected one after another until the one-week test period expires.

SEA PROBE, expressly designed for deep sea exploration and recovery, is owned and operated by Ocean Search Inc., a subsidiary of the Aluminum Company of America, and is under contract to the Navy for the test period. The MONITOR operation provides an excellent opportunity to realistically test SEA PROBE's capabilities.

## OPERATION PLAN

SEA PROBE 74-331-408

### 1.0 OBJECTIVES

#### 1.1 Primary:

(a) To determine the characteristics, capability, and efficiency of the SEA PROBE in operations involving inspection and documentation of shallow wrecks.

#### 1.2 Secondary:

(a) To inspect and obtain photographic documentation of 11 magnetically located wrecks near Cape Hatteras.

(b) In the event one of these hulks is the Naval Vessel MONITOR, a special effort is required to insure the acquisition of full-high quality photographic coverage suitable for the production of a montage for public display.

### 2.0 FACILITIES INVOLVED

ALCOA MARINE SHIP-SEA PROBE

### 3.0 SCHEDULE

Depart Moorehead City, N. C.	31 Mar 74 AM
Arrive Site #1 Operation Area	31 Mar 74
Depart Operation Area	7 Apr 74
Arrive Moorehead City, N. C.	7 Apr 74

Schedule may be adjusted as deemed necessary by the Officer in Charge of the Expedition (OCE).

### 4.0 AREAS OF OPERATION

There are 11 specific targets to be investigated. The order of investigation will be as listed below:

#### 4.1

Site #	Lat	Lon
Site #1	35°00.1'N	75°25.0'W*
Site #2	34°54.7'N	75°24.4'W
Site #3	34°58.2'N	75°24.6'W
Site #4	34°53.3'N	75°30.5'W
Site #5	34°46.0'N	75°31.0'W
Site #6	35°01.0'N	75°25.0'W
Site #7	34°54.6'N	75°25.9'W
Site #8	35°02.4'N	75°29.1'W
Site #9	34°52.6'N	75°26.8'W
Site #10	34°57.2'N	75°26.4'W
Site #11	34°50.7'N	75°32.3'W

#### 5.0 EQUIPMENT/SUPPLIES REQUIRED

##### 5.1 Equipment

- (a) Instrument POD with TV and still cameras.
- (b) LORAN C and SATNAV
- (c) FATHOMETER
- (d) Photo Processing (to negative)
- (e) Photo Processing (to positive)
- (f) Photo copy (to scale)
- (g) Light table
- (h) Layout table - at least 4'x8'

##### 5.2 Supplies

- (a) Tri X or equal film - 30 rolls (150')
- (b) Positive Duplicating film - 30 rolls (150')
- (c) Copy camera film
- (d) Masking tape - 10 rolls

(e) Rubber cement - 10 bottles

(f) White paper 24" side - 100' roll

## 6.0 GENERAL OPERATING PROCEDURE

### 6.1 Hulk Location

(a) Initial contact will be attempted by searching the area by fathometer. Parallel passes at 100' intervals expanding from the assumed wreck position will be made to a distance of 1000 feet. The direction of the baseline will be selected on the basis of weather and ship handling characteristics. Speed will be selected for best bottom display - approximately 3 kts.

(b) If the above method of operation is not successful, the same area will be searched using the side scan sonar. The best speed for operation of this equipment will be used (assume 1-2 kts.).

(c) If the side scan sonar method of operation is not successful, the same area will be searched using the TV system. This will be done at the best TV speed (approx 1 kt.). The pattern will be an expanding box centered at the assumed wreck site. If weather or other factors do not favor this pattern, alternatives will be sought.

### 6.2 Documentation of Hulk

When the hulk has been located, the still cameras will be operated at maximum rate and the ship will maneuver using the TV as a guide to completely photograph all portions of the wreck plus the area immediately

adjacent to it. The photo height will be adjusted to the best tradeoff between coverage and image quality. A desirable height is 11 feet.

### 6.3 Hulk Site Identification

When the film in the camera pod is completely expended, a buoy shall be launched to mark the wreck location.

### 6.4. Transit to new site

When the POD is retracted, the ship will proceed to the next site, and will commence to search as in (6.1). When the hulk is located the procedures of 6.2, 6.3, and 6.4 will be repeated.

### 6.5 Re-examination of Hulk

After the photographic documentation has been reviewed for a hulk, a determination will be made as to the necessity for additional photo documentation or object recovery. If either of these requirements exists, the ship will revisit the appropriate site, and re-photograph or recover objects as required, at the completion of the current documentation underway.

### 6.6 Area Clearing

When it has been established that no further documentation of a hulk is desired, and that an adequate refined position has been established, the moored buoy will be recovered during the next site change evolution.

## 6.7 Completion

When all hulks have been fully documented, or when necessary to depart to reach port by noon, 7 April, or if weather dictates discontinuation, the ship will depart the area. All moored buoys will be removed before final departure.

## 7.0 SUPPORTING PERSONNEL

A number of people will supplement the regular operating personnel. These are selected to supply specialized expertise and experience in one or more of the areas of effort involved. These persons will be divided into teams and will be made responsible for analysis of the documentation and will make recommendations to the OCE.

CDR C. JONES	NAVXDIVINGU	OCE
ERNEST PETERKIN		NRL
EDWARD MILLER		Naval Academy
WILLIAM ANDAHAZY		NSRDC
CHESTER L. BUCHANAN		NRL
ANDREW RECHNITZER		
GORDON WATTS		NORTH CAROLINA
JOHN NEWTON		Duke
DR. HAROLD EDGERTON		MIT
DORETHY NICKOLSON		NATL. GEOGRAPHIC
ARCHIE GALLOWAY		CHINFO
NATHAN BENN		NATL. GEOGRAPHIC
SANDRA BELOCK		NC

## 8.0 COMMUNICATIONS

Communications to shore activities will be handled via the standard ship-shore radio-telephone system. No information is to be released to the news media without permission of the OCE.

EDITOR'S NOTE

The misunderstanding between John Newton and Commander Jones went unresolved until the day before the Seaprobe was scheduled to depart Morehead City, N. C., in fact Commander Jones did not know that any real misunderstanding existed until 31 March. On that day, Commander Jones received the letter dated 29 March from John Newton outlining a list of prerequisites to the Seaprobe voyage.

Inserted here is a copy of the prerequisites and Commander Jones' point by point reply. Followed by Commander Jones' narrative of the expedition, the log kept by Ernest W. Peterkin as the official record of the operation and the final evaluation report.

In all over 1200 photographs and several TV video tapes were made of the hulk.

Duke University Marine Laboratory  
Beaufort, North Carolina 28516

March 29, 1974

Cdr. Colin Jones, Head  
Naval Experimental Diving Unit  
Washington, D. C.

SYNOPSIS: Requisites for Archives and History, Duke, MIT, and National Geographic Society participation in Alcoa Sea Probe Cruise, March 31 - April 7, 1974:

- 1) Have two archeologists aboard Alcoa SeaProbe at all times to provide continuous supervision of data recording and data recovery;
- 2) Have entire archeological team aboard when recovering any samples or materials associated with or near Site #1;
- 3) Spend entire six (6) days on Site #1, unless in the archeologists' opinion this is not the MONITOR;
- 4) All Navy Personnel, Alcoa Crew, and other civilians, are to sign the literary release (NGS) before sailing;
- 5) Respecting these literary rights and to avoid disrupting working procedures, press personnel will not be permitted aboard the Alcoa SeaProbe while at Sea;
- 6) Good quality duplicates of all site related data will be delivered to the State of North Carolina, Department of Cultural Resources, Division of Archives and History, immediately upon termination of the cruise;
- 7) All samples and/or artifacts from the site will be processed by North Carolina State Archeologists and will become the property of the State of North Carolina.

(Signed) John G. Newton

Duke University Marine Laboratory  
Beaufort, North Carolina 28516

March 29, 1974

Cdr. Colin Jones, Head  
Naval Experimental Diving Unit  
Washington, D. C.

TEXT OF SYNOPSIS: Archeological objectives of on-site work

- 1) A comprehensive photomosaic of the entire site
- 2) Recovery of camera and pinger
- 3) Complete video taping of forward section
- 4) Recover selected samples- contingent upon quantity and quality of photomosaic, the latter to be directed and produced by and in conjunction with experts in this field;

RATIONALE FOR ARCHEOLOGICAL RESEARCH TEAM:

- 1) On-site work must be conducted by professional archeologists experienced in on-site investigation
- 2) Work is to be done by a professionally competent team experienced in the archeological survey, excavation, and recovery of data pertinent to 19th century sites;
- 3) The diverse nature of archeological data demands expertise of specialists trained in fields tangentially related to archeology. Yet, such specialists must also possess experience in archeological excavation. The research archeological team brought to the Alcoa SeaProbe task by the Division of Archives and History and the Duke University covers the expertise for a) observation and investigation of the shipwreck site in question; b) recovery of artifacts; c) radiography of specimens; d) photography of specimens; e) stabilization and preservation of specimens; f) documentation (location) of specimens and the wreck. No persons or specialists lacking archeological experience are qualified to conduct the above in a singular fashion;
- 4) Due to the inherent complexity involving observation of the wreck, recovery, identification, and preservation of the wreck and associated specimens which will yield an

Cdr. Colin Jones  
Page 2

ultimate evaluation and synthesis of the site and its historic significance, it is imperative that the archeological team available be included as participants in the Alcoa SeaProbe operations;

- 5) A minimum of two (2) professional archeologists employed by the State of North Carolina, Department of Cultural Resources, Archeology Section, must be aboard SeaProbe at all times during the MONITOR search, March 30-April 7, 1974. Additionally, when objects are to be raised from a wreck site, the entire archeological team must be on-hand for consultation and data recording.
- 6) Objects or artifacts to be retrieved from the MONITOR site must have been recorded or otherwise documented on tape, photographs, and/or sketches prior to raising or recovering said objects;

#### Summary

The U.S.S. MONITOR is an archeological site. Whether owned, claimed or secured by the Navy, General Services Administration (Title 3, MPRSA, 1972) or other authority, the historical significance and integrity of the site can only be fully determined by competent archeological investigation. Archeology is a profession. Its procedures and ethics will not be absorbed in a confusion of priorities which dictate or suggest deviation from internationally accepted standards. The Duke Marine Laboratory (principally John Newton, Marine Superintendent), and the State of North Carolina Department of Cultural Resources (Stephen Gluckman, Chief, Archeology Section), and the National Geographic Society subscribe and are parties to these professional creeds and commitments. The MONITOR belongs to and has been paid for by the public. The demeanor and scientific manner in which the MONITOR'S history and significance are finally assessed will be judged by and in the court of public opinion.

(Signed) John B. Newton

1. In Mr. Newton's letter of 29 March, hand delivered on 31 March, he specifically stated that "objects or artifacts to be retrieved from the Monitor site must have been recorded or otherwise documented on tape, photographs, and/or sketches prior to raising or recovering said objects."

2. On Wednesday, 3 April we had not been able to develop and print all the photographs taken and thus had not sufficient documentation to permit retrieval of objects. This was concurred in by Dr. Schneider from the State of North Carolina.

3. At no time did I place any other stipulation on retrieval of objects than the requirement that we get complete site documentation first to preclude moving or damage to objects which might forever lose information of value to the scientists.

I declined to state that the wreck was the Monitor—on the expressed basis that I was not an expert on such matters and would defer that judgment to the experts.

4. At the meeting held at NRL on 11 March and attended by Mr. Newton, I disclosed that only 13 berths would be available aboard SeaProbe for all participants, Navy included. This was subsequently verified to Mr. Newton by phone, and he provided me with a list of Duke/MIT/N.C. state participants as follows:

1. Mr. Gordon Watts - N. C. State
2. Miss Sandra Belock - N. C. State
3. Mr. John Newton - Duke
4. Dr. Harold Edgerton - MIT
5. Miss Dorothy Nichol森 - National Geographic
6. Mr. Nathan Benn - National Geographic

First alternate - Mr. Fred Fehling - MIT  
Second alternate - Mr. Ed. Jaeckel - MIT

The six persons listed above were all provided with berths aboard the SeaProbe. There were not 19 berths for the scientific party—only 13. The other 7 were as follows:

1. Cdr Jones
2. Dr. A. Rechnitzer
3. Mr. Chester Buchanan
4. Mr. E. Peterkin
5. Midn 1/c Ed Miller
6. JOC Archie Galloway
7. Mr. W. Andahazy

These personnel were all effective and necessary participants to accomplish the Navy goals on this operation. This list of participants was discussed with Mr. Newton two weeks prior to the commencement of the exercise.

The inability of Mr. Newton to return to the SeaProbe, and the inability to effect other personnel transfer subsequent to Wednesday 3 April was due to adverse weather.

Mr. Gordon Watts spent the entire period of the operation on board the SeaProbe.

Mr. Newton made the original stipulation that nothing be done to disturb the wreck site until it was fully photographed. He then wanted to bring up the camera and other items as a demonstration to the press. This was contrary to the advice of the archeologists aboard and was thus not done.

### Narrative Summary

The ship sailed from Morehead City as originally planned on Sunday 31 March. However, up to the last minute prior to sailing there remained a matter of controversy which centered essentially around who was going to control the operation. This controversy was basically between Mr. John NEWTON from Duke Marine Laboratory and myself. Mr. NEWTON presented a series of specific demands, enclosure (3) to the basic letter. I was unable to meet these demands and provided him the following rationale.

a. Item #1 was to have two archaeologists aboard ALCOA Sea Probe at all times to provide continuous supervision of data recording and data recovery. However in the original list of personnel which Mr. NEWTON had provided to me, he had been given a specific number of berths on the Sea Probe for his party and had elected to bring along himself, Dr. EDGERTON, Miss Dorethy NICHOLSON from National Geographic, Mr. Nathan BENN from National Geographic, Mr. Gordon WATTS from the state of North Carolina and Miss Sandra BELOCK, an artist employed under contract by the Duke Marine Laboratory. Mr. NEWTON also told me that his first two alternates in the event any additional space could be made available were a Mr. Fred FEHLING and Mr. Ed. JACKEL, engineers from MIT. My answer to Mr. NEWTON so far as his requirement for an additional archaeologist was that he would have to take someone off the list from his group and I suggested that possibly one of the two artists which he had included could be removed without any great loss to the party. This was not a satisfactory answer to Mr. NEWTON.

b. Item #2 was to have the entire archaeological team aboard when recovering any samples or materials associated with or near site Number 1. I was unable to promise him that we would do this although I did promise him that if the weather conditions permitted transfer from the Army LCU to the Sea Probe at the time we wanted to recover material, we would make every effort to transfer these personnel to the Sea Probe for the day and that the Skipper of the Sea Probe had agreed to this so long as the LCU remained in the vicinity. This was not a satisfactory answer, so far as Mr. NEWTON was concerned.

c. Item #3 was to spend the entire 6 days on Site 1, unless in the archaeologists opinion this was not the Monitor. I was unwilling to permit this demand because I had made plans to use the Sea Probe to evaluate a series of 11 sites, we had extensive magnetic anomaly survey data on these other sites, and it was our desire to attempt to correlate this magnetic

anomaly survey data on these other sites, and it was our desire to attempt to correlate this magnetic data with the actual findings at the site. Further, we were to utilize our time as was most efficient, thus while developing the first pictures and checking them we would go to other sites, and return to Site 1 when we could be effective there.

d. Item #4 was that all Navy personnel, ALCOA crew and other civilians sign literary release for National Geographic Society before sailing. I refused to do this.

e. Item #5 was respecting these literary rights and to avoid disrupting working procedures, press personnel will not be permitted aboard the ALCOA Sea Probe while at sea. I refused to accede to this demand as well, pointing out that if Duke brought the press out I could not than refuse to let a pool group aboard.

f. Item #6 was that good quality duplicates of all site related data will be delivered to the state of North Carolina, Department of Cultural Resources, Division of Archives and History immediately upon termination of the cruise. Once again I could not guarantee that we would do this because I didn't expect we would be able during the course of the cruise to make satisfactory copies. I did guarantee Mr. NEWTON that I'd make every effort to provide them with a set of all the data as quickly as possible after the termination of the cruise.

g. Item #7 was that all samples and artifacts from the site will be processed by the North Carolina State Archaeologists and will become the property of the state of North Carolina. I did assure Mr. NEWTON that this was my intention.

As a result of the impasse on the aforementioned demands presented at 6:00 am. on Sunday morning March 31st, Mr. NEWTON informed me that he and Mr. WATTS would have to seriously re-think whether they cared to participate in the operation. When he informed me of this, I simply told him that I could not permit myself to be blackmailed by threats on his part to pull out, and that we would sail at 1830 whether he was aboard or not. Unfortunately, because of this the navigation equipment which we, and the Sea Probe had been depending upon, was not delivered onboard Sea Probe by Mr. NEWTON. He finally decided late Sunday afternoon after another meeting to participate with the expedition. However, at that point it was too late to change the location of the navigation system which was then at Cape Hatteras aboard the LCU. The ship sailed as scheduled and arrived at Site 1 approximately 0815 Monday morning. Almost immediately upon arriving in the vicinity of the

site, fathometer contact was made with the wreck. However before the Pod with the side scan sonar and cameras could be put in the water, fathometer contact was lost and due to the lack of a precision navigation system the rest of the day was spent in reacquiring the target. Details of the search and photography that took place in the next two days are provided in the log attached as enclosure (5) to the basic letter.

To summarize the search and photography that was accomplished, approximately 1200 black and white photographs, 450 color photographs, and in excess of 4 hours of Video Tape recording was made of the Monitor Site. This was accomplished Monday night, Tuesday and Tuesday night, with the last color photography completed at about 0500 Wednesday.

Wednesday night was spent searching at Site 2 and then Site 4 with no target located at either site. By noon Thursday it was apparent that we did not have full coverage of the wreck at Site 1 with the black and white photographs. The ship returned to Site 1 and was delayed several hours Thursday afternoon providing medical assistance to the LCU. Weather conditions continued to worsen, and Sea Probe did not accomplish any further work.

My general comments regarding the Sea Probe are as follows:

a. The ship does not have an adequate search capability. The normal search capability involves using side scan sonar on the pod. The ship is limited to 1 knot or less through the water with the Pod down. In addition to the inability of the Sea Probe to function satisfactorily in the search mode, once a target was acquired, considerable difficulty was experienced in staying with the target, although the maneuverability of the ship is phenomenal. The difficulty arose when the ship drifted slightly off the edge of the target. As soon as the target was out of visual contact, if the mate driving the ship made the wrong move to get back on the target, he would completely lose it and another sonar search would be required. This happened several times. After a request to the Commanding Officer of the ship, a 13 kilohertz pinger was placed on the bottom. This helped stay on the target because the pinger gave us a reference. A better reference, either with a precision navigation system or pinger, is needed.

b. The ship was not experienced in the business of photomapping targets and a few mistakes were made in the techniques of operating the cameras and coordinating the ship's movement. As a consequence putting together the pictures taken will be a more significant job than it otherwise needed to be.

c. The ship has a tremendous ability to maneuver—it can go in any direction up to the limits of its propulsion system against tide, wind and current. The ship is limited to about 7 kts ahead.

d. The ship provides an ideal work platform for an open sea site since it can hold position without putting any anchors out. This provides a "Deep Water" mooring capability.

e. The Sea Probe cannot operate in winds much in excess of 15-20 kts, and has difficulty lowering the drill string if rolling more than 10 to 15 degrees. This limitation must be recognized.

f. The ship is not routinely equipped with a precision navigation system and does not have a doppler sonar navigation system. Some system is needed for establishing a precision grid at the work site, either precision navigation, bottom pinger reference, or doppler. The present pinger may be adequate in deeper water.

On Wednesday morning considerable delays were experienced in all areas because the ship was anxious to put on a demonstration for the press, expected to arrive at about 0900. As

a consequence, although the weather had improved from the previous day, little was accomplished from about 0500 until the press personnel came aboard at 1130. It had been the intention of the ship to attempt while the press personnel were aboard to recover some artifacts from the wreck site, however since we did not have a photographic picture of the site, it was my opinion and was concurred in by the archaeologist from North Carolina that such a move would be premature. A press conference was held aboard the press boat, attended by Mr. Gordon WATTS, Mr. John NEWTON, Mr. Chester BUCHANAN from NRL, myself and Dr. Kenneth SNIDER from the state of North Carolina. After the initial briefing, a group of six press personnel came aboard as a pool to shoot some pictures on the Sea Probe and interview some of the other personnel on the Sea Probe. They departed the Sea Probe at approximately 1300, at which time plans were made to move from Site 1 to Site 2. We received the precision navigation system by helicopter from the beach at about 0930 and had it installed by 1300. After the press departed at 1300, the Sea Probe made plans to move south to Site 2 and commence a search. Simultaneously efforts were underway to develop the preliminary photographic montage and verify that adequate photography of Site 1 had been completed. A personnel transfer with the LCU, which had returned to the site, was requested to provide a relief for Mr. NEWTON who had departed with the press boat. Upon completion of the personnel transfer, Sea Probe left for Site 2. No success was achieved at finding anything at Site 2. After a search of 1600 feet around Site 2, the Sea Probe moved to Site 4. This was because Site 4 was the site with the most magnetic data. This site was thoroughly searched until Thursday afternoon at which time the Sea Probe returned to Site 1. No target was found at Site 4. A sufficient number of the photographs had been printed and identified of Site 1 to indicate that another photo run was needed to complete the montage. Upon arrival at Site 1, a request was made by the LCU for medical assistance. The weather was steadily worsening and considerable difficulty was experienced in providing a transfer of the Sea Probe corpsman. After this was accomplished, he treated the injured man on the LCU and was returned to the Sea Probe at about 1800. Sea Probe then moved to Site 1 and a decision was made by the ship to await better weather before putting the Pod in the water.

Better weather did not develop and no further photography or recovery was possible. The Sea Probe had difficulty maintaining station at Site 1, and finally at about 2100 Saturday departed for Morehead City. The operation was terminated.

In summary, the Sea Probe is basically suited to shallow water search and recovery, but needs a few additional pieces of equipment to be effective. The most useful of these would

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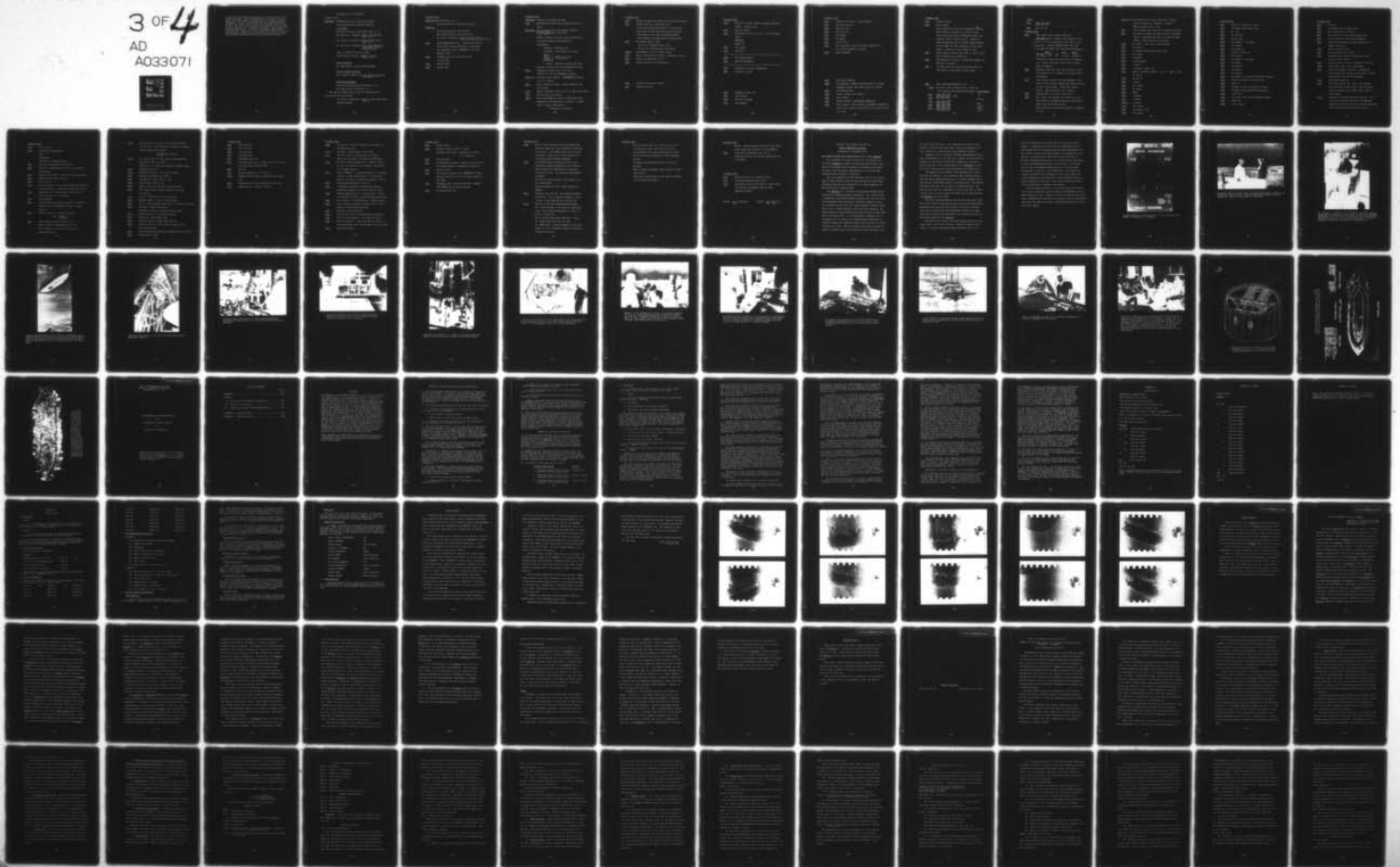
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be precision navigation equipment and a towed fish with side scan for search. Available hardware could easily be integrated into the present configuration to overcome these difficulties. The ship functioned well—the personnel worked together as a team, and the ship has outstanding maneuverability. The lack of requirement to establish a moor in order to hold position over a work site provides a very unique and valuable capability. Sea Probe is somewhat underpowered which places a limitation on the wind and current that she can hold position against, and this factor must be kept in mind when planning operations in areas of significant current.

Log Kept by E. W. Peterkin

30 March 1974

1200-1600 - Moorehead City, N. C. Municipal Dock

Following personnel reported aboard:

U. S. Navy

CDR Colin M. Jones, USN, NEDU, Wash. D. C.

Mr. Chester L. Buchanan, Naval Research Lab.  
Wash. D. C.

Mr. Ernest W. Peterkin, Naval Research Lab.  
Wash. D. C.

Mr. William J. Andahazy, Naval Ship Research &  
Development Center  
Annapolis, Md.

Midn l/c Edward M. Miller, USNA

Chief Archie Galloway, CHINFO, Pentagon  
Wash. D. C.

Duke University

Mr. John Newton, Marine Superintendent

State of North Carolina

Mr. Gordon P. Watts, Div. of Archives & History  
Kure Beach, N. C.

National Geographic

Miss Dorethy Nicholson, Washington, D. C.

Mr. Nathan Benn, Washington, D. C.

The day was spent making plans for operations and  
touring the ship facilities.

Dr. Andrew Rechnitzer, Chief of Naval Operations  
(OP-23)  
reported aboard.

31 March 1974

0800-1200 Moorehead City, N. C.

Continued review of operations plans.

1200-1600

Following personnel came aboard:

Miss Sandra Belock, Duke University

Dr. Kent A. Schneider, North Carolina State  
Cultural Resources Department

1830

Departed Moorehead City. Underway for Operations Area off Cape Hatteras in compliance with Operations Plan "SEAPROBE 74-331-408"

Weather clear.

1920

Dropped pilot off a Beaufort Inlet

Course 150<sup>o</sup>T

2315

Course 090<sup>o</sup>T

2345

Course 045.<sup>o</sup>

01 April 1974

0000-0400 Underway for Operations Area

0510 Cape Hatteras Light House bearing  $019^{\circ}$  at 33 miles.

0810-0815 Radio contact with Army Reserve Vessels  
LCU ETA #1488) 1100 on Site #1  
T Boat #3589 )

Captain Crechton and Cdr. Jones hold meeting to discuss safety area operations.

Assignments:

Peterkin - Maintain log

Buchanan - Devise Plan of the Day

Watts )  
Miller ) Wreck I.D. from  
Belock ) T.V. monitor  
Nicholson)

Newton - Maintain contact with LCU

Buchanan suggests use of transponder at site

0818 Seaprobe on station over site No. 1  
( $35^{\circ}00.1'N$ ,  $75^{\circ}24.5'W$ ) (Newton coords)

0842(-44) Vertical Sonar contact. FATHOMETER indicates an 18 ft. relief.

0900 Capt. Crechton conning search operation and pod control.

1114 Target starboard side, 300 ft. on side scan sonar.

1125 LCU one half mile astern

1345 Noted typographical error in Operations Plan  
Seaprobe 74-331-408 page 2, Site No. 1 coordinate for Long. should read

$75^{\circ}24.0'W$  vs  $75^{\circ}25.0'W$

01 April 1974

1407 Target on port side picked up by side scan sonar.

1419 Target 50-150 ft. starboard side.

LCU has been operating north of us with side scan sonar and Del Norte positioning navigation system using fixes on Diamond Shoals light platform and Cape Hatteras Light House.

1438 Del Norte reads on LCU:

98,114 ft. Diamond Shoals Light

63,102 ft. Cape Hatteras Light House

1439.5 Pod dropped to 50 ft. above bottom

1537 Sonar indicates over target. Pod down to 40 ft.

1553 Target to starboard 100 ft.

1605 Object visible on TV (vertical)

1609 Possible false keel sighted

1612 Interior visible

01 April 1974

1613        Position fix data Mosaic started moved off  
screen    Every 8 sec.

1617        Back on screen

1630        Position fix data = 32 1/2 - 32 3/4 fathoms  
depth

DELNORTE

LORAN "C"

1700        Off target

1722        200° PGC

-----  
0850        Pod entered water

0920        Down and operating

-----  
2230        Recontact on target (momentary)

2250        Contact on target

2254        Dropped pod one foot

2255        Lost contact

2310        Contact on target

2311        Lost target

02 April 1974

0047 Contact with target - photographing  
0057 Pod down one foot  
0058 Down one foot  
0103 Down one foot  
0110 Off target  
0117 On target  
0118 Up two feet  
0136 Pod retracted - still on target (appeared to  
be a long cylindrical object)  
0143 Capt's Remarks

0210 Pod brought aboard  
0355 Pod launched. changed configuration to include  
droppable pinger and fishing rod for ranging.  
0415 Pod started down  
0558 Visual contact with target.  
0602 Lost contact  
0612 Visual contact, transponder implanted  
0626 Lost contact. Dense school of mackerel frequently  
block view. Current from 210° at 1 kt. Wind gusting  
to 30 Kts.

02 April 1974

0631 Visual contact

0634 Lost contact

Wind gusting to 25 kts off starboard. <sup>Bow</sup> Quarter.

Ships heading changed to put wind on bow.

This action put ship in quartering swell with gyrating motion induced in pod. Unable to hold transponder due to conical upward pattern is less than 200 feet diameter in this water depth. Continue to hold target on SLS.

0643 Ships heading changed from 220° to 210° to gain more favorable sea conditions.

0653 Pod pulled for stowage. Conditions deemed too adverse to operate.

0845 1st mate says the pinger was placed about 30 feet north of the center of the target

0854 Data from Photographer's notes

1 Apr. Run #133, 220 ft, Focus 10 ft. 1/200 sec

f 16, Frames 728-299 TRI-X 35mm Kodak Camera Timed

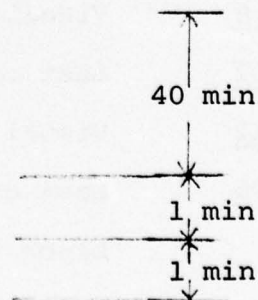
1616 Ship Head 186°  
POD head 185° - 194°

1620 POD head 182°

1721 Ship head 200°  
POD head 194°

2228 Ship head 200°  
POD head 210°

2251 Ship head 200°  
POD head 213°



2 Apr.

0047 Ship head 200°  
POD head 216°

0120 Out of film

02 April 1974

0914 Data copied from Seaprobe Deck Log

~~0000-0300 Vessel underway from Morehead City,  
N.C. to site of operations 15 mi SSE of Cape  
Hatteras. Heading 047°G055°PSC. 88% 0105  
c/c 052°G 064°PSC. 0234 c/c 055°G 067°PSG  $\xi\omega?$~~

Time	WX	Temp		Sea	Wind	Swell
		—	Wet			
01	CLR	61	55	55	5 kt NE	4,5, SXW

\* Decided to copy with 3M machine on separate log. (Final decision to copy data on blank deck log sheets)

0930 Buchanan began dark room test prints of first film from Run 133. Problems with heat sensitive paper.

1215 First contact prints from photographer. All hands turn-to getting experience making mosaics of wreck photography. Using 35mm contact prints. Work continued until supper.

1800 Resumed work on mosaics of Run #133.

1900 Cdr. Jones sent message in morning via ship-shore phone to SUPSALV requesting helicopter drop of Del Norte NAV system.  
Chief Galloway filed morning report to CHINFO. at 1330.

1900(cont'd) LCU departed site about 1000 due to rough seas and mechanical problems. Arrived Hatteras Inlet about 1730.

2010 Probe lowered over Site #1 for Camera Run #134.

2020 Mr. Newton called Duke News Service via Walkie Talkie - requested Del Norte to drop via helicopter. Press boat due in morning.

2104 On target - port side - near boilers

2105 Off target

2123 On target. Coming up on port side

2127 Off target

2134 On target

2137 2 photographs

2138 1 Photo

2142 1 picture - down 2 ft

2143 Down 2. possible redder - up 2 ft. Skeg in view  
Up one ft.

2244 Up one ft.

2245 1 photo

2246 Off target

2247 On target

2248 Photo

2250 3 photos

2251 2 photos

2251.5 2 photos

2253 Off target

2254 On target (X) (X)

2257 Off target

02 April 1974

2159 Search out limits of vessel  
2201 On target over engine room  
2202 (X) (X)  
2204 Up one foot  
2205 Up one foot  
2206 Off target - on target  
2208 Off target  
2210 On target (X)  
2213 Turret in view (X)  
2220 Off target  
2221 On target - Off target  
2226 On target  
2229 Off target  
2232 On target  
2242 Off target  
2252 On target - over stern proceeding forward.  
2300 Photo run stern to bow port side  
2305 End run  
2306 Contact on stern proceeding forward  
2308 Wandered back, started forward again  
2314 Over bow?  
2324 On target over stern proceeded forward  
2327 Down 3 ft.  
2328 3 up, 2 down

03 April 1974

0000 Over bow

0025 Retracting pod to change film

0110 Pod retrieved and on deck.

0210 Pod launched in color photography mode.

0252 Visible contact, began photographing.

0405 Secured photographing, began examination of camera and pinger.

0420 Began retrieving pod.

0512 Pod retrieved and on deck.

0815 Resumed mosaic work on original Run #133.  
(Run No. 728 on film)

0914 Chart position Site No.1 35°00.23', 75°24.32'

1000 Press boat "Capt. Stacy" alongside.

1005 Marine helicopter alongside. Dropped Del Norte Navigation system on helio deck. Transferred parts for LCU to helicopter.

1025 Helicopter departed

1030 Scientific party. Cdr. Jones, John Newton, Ken Schneider, Gordon Watts, Chief Galloway, Chester Buchanan went aboard Capt. Stacy to brief press.

1107 Preparing Del Norte Navigation system. Holding search operations by order of Seaprobe Captain until press aboard to witness pod water entry and television coverage of event.

03 April 1974

1133 Pod in water

1145 Press party came aboard:  
CBS  
Independent  
Ken Ringle - Washington Post

1200 Peterkin interviewed by Ken Ringle

1208 Over bow - exceptional clarity. No streaming  
of plankton.

1215 Passed over turret. Looked like sliding hatch.

1223 Andahazy sees chain over bow

1230 Pod up 12 ft.

1248 Boat alongside to take press ashore and departed.  
John Newton went. Ed Jaeckil, MIT came aboard.

1300 Retracted pod. Taking photos on way up to  
determine limit of visibility.

1315 LCU alongside

1330 Transferred one personnel aboard, Ed. Jaeckil,  
MIT. (2) John D. Broadwater, State of North  
Carolina

1545 Arrived Site No. 2. Nominal position  
Lat 34°54.7N  
75°24.4W

1603 Began lowering pod to about 350 ft.  
Using Del Norte Transponder Model 202a  
Bill Andahazy consulting with Captain on  
anomaly position.

1615 Navigational fix used in search control chart  
for Site No. 1 was  $35^{\circ}01.8'N$ ,  $75^{\circ}24.4'W$  - Captain  
Turret Ranges on Del Norte:  
98,202) Grant Mullen  
63,156)

1630 On site #2. 248 ft. out, begins search pattern  
ship head  $180^{\circ}T$  pod  $030^{\circ}$   
Added 60 ft. of pipe and dropped off 1000ft. ENE

1640 Proceeding to site

1645 Dropped to 328 ft. - 60 ft. off bottom

1648 Changing pod heading to  $180^{\circ}T$

1650 Proceeding to site, 400 ft. away

1656 Site on port beam 120 ft.

1700 Moving to 200 ft. due west and pass south

1715 Cdr. Jones, Glenn, Watts, Jaeckil, up on top  
of pipe rig.

1735 1100 ft. west, 500 ft. N last position

1750 Passed 1,000 ft. west of contact area.

1800 510 ft. south, passed west 1,000 ft. Started 500 North.

1812 Hovering - Sonar tracer down  
Andahazy on bridge to direct search pattern

1833 Sonar tracer up. Continuing search.

1922 Ended run. Pod heading  $153^{\circ}$

1929 Cleaning sonar recorder head complete

1932 Start run 500 ft. east, 1,000 ft north of tar-  
get running south

1936 Rotated pod head incorrectly (went from  $70^{\circ}$  to  $210^{\circ}$ )

1939 Stopped pod at  $144^{\circ}$

03 April 1974

<u>1940</u>	160° pod head
<u>1941</u>	197° pod head
<u>1942</u>	178° pod head
<u>2008</u>	Completed pass
<u>2017</u>	Completed south run
<u>2019</u>	Starting north run to clear site 150 ft. east pod head 160° Ship head 180°
<u>2028</u>	Pod 162
<u>2031</u>	Closest approach to site 250 ft.
<u>2038</u>	Reached end of track. Positioning for south run.
<u>2125</u>	Retracting pod after completing south run.
<u>2215</u>	Depart Site 2. bound for Site 4.

04 April 1974

0045 On station at Site 4, prepare to put down instrumentation pod.

0110 Pod down - begin search - East West

0115 Possible target, starboard side of ship.  
Target most probably is bottom irregularity.

0136 Del Norte System dropped out. Trouble lights are on. No indication of problem. Ed Jaeckil will attempt repair.

0155 Repair complete - isolated problem to low supply voltage of lead acid batteries - Voltage was down to 23 volts. replaced one battery - all ok.

0200 Resume search pattern at Site 4.

0204 E. Peterkin reported to bridge that Search Fathometer dropped out at about 0115 to 0135.

0344 Target acquired 300 ft. off port side. Should be located at 134350 x 115100 (Pod heading South)

0400 Close target. No confirmation. Resume survey.

0500 Capt. Crechton reported a target east of site. Target of questionable quality.

0515 Del Norte system expired.

0525 Back on line after cleaning battery terminals.

0540 Try 24 V power supply. No positive results.

0600 Revert to battery. Ship now 1800 ft. north of last track (E-W) will go due West for final track.

0610 System down again

04 April 1974

0620 Resume survey

0750 Possible target 131106 x 113429  
Probably sand ridge. Proceeding on search  
W. J. Andahazy

0946 Running South

1235 Investigating contact. Possible rock out crop  
or ballast stones. Proceeding to Site #3.

1550 LCU off stern

1615 Transferred corpsman from SEAPROBE to render  
medical assistance to crew or party member of  
LCU 1488.

1710 Corpsman Calkin returned from LCU. Removed  
large <sup>hook</sup> from hand of army corpsman.

~ 1845 On station Site #1.

05 April 1974

0030 Strobe light reflector and bulb broken over Site #4. Water got into telemetry system and blew fuses. Unit render repair by on board personnel. Planning to start operations in the morning when weather slackens.

0110 LCU departs area for Hatteras Inlet after attempting dredging operations over Site #1. Heavy weather and expiration of Army crew time force return. No transfer of personnel attempted.

The day was spent working on the mosaics of the wreck photos.

Chief Galloway sent off a news release to CHINFO.

0900 Underway over Site #1. The weather prevents operations. Still working on mosaic. Electronics on pod repaired and standing by.

1335 Meeting in Wardroom regarding photography Cdr. Jones decides to let Alcoa to copy data film. Alcoa retains ownership of film as a matter of practice.

Watts requests duplicate negatives. Alcoa can supply duplicate film at cost.

Dr. Rechnitzer - original negatives and video tapes to go to a national archives with advice of Naval Historian.

05 April 1974

Chief Galloway says he is making a press kit to release to press upon arrival at port.

Grant Mullens will make representative video prints and photos available to team representatives.

Buchanan has documented prints for montage purpose.

Watts suggests permanent copy be made of video tape before.

Alcoa will contact Navy to see cost of copying film and making montage.

06 April 1974

Mullen - make permanent record of basic data.  
Video tapes are available to team members.

2000

Underway for Moorehead City, N. C.  
Departing Site #1 and ceasing operations due  
to weather.

07 April 1974

~1015

Picked up Pilot for Beaufort Inlet.

1236

Alongside Moorehead City pier.

1245

John Newton came aboard and all hands signed  
the National Geographic Society flag.  
Expedition ended.

Signed E. W. Peterkin  
NRL

Signed Colin M. Jones  
CDR USN

Abstract from paper presented the

Marine Technology Society

Conference 25 September 1974

SEA SURFACE SEARCH AND VERIFICATION BY R/V ALCOA SEAPROBE

As a measure on the part of the Navy to evaluate the R/V Alcoa Seaprobe in search and recovery operations, a program was initiated for the purpose of searching and finding a wreck on the sea floor, photographing it in detail and recovering some objects of interest.

The site selected for the evaluation was an area southwest of Cape Hatteras that had been surveyed by the Project Cheesebox team and also explored by Dr. Harold Edgerton of MIT and the Duke research team.

The Seaprobe is a 243-foot all aluminum research vessel designed for deep-sea working operations. The ship provides a dynamically positioned working platform with the use of two Voith-Schneider diesel-electric cycloidal propeller units, one forward and the other aft, which provide a hovering capability over a target against ocean winds and currents. The vessel employs a semi-ridged pipe string through an open well deck in the ship's hull for the purpose of deploying an instrumented pod for search and identification operations or recovery systems for sampling studies and retrieval of objects from the sea floor. The drill pipe string can be lowered to depths of 18,000 feet and can recover objects weighing up to

200 tons from 6,000 feet. The instrument pod used on this operation carried side-scan sonar, target illuminating systems, television, 35mm cameras, and required telemetry.

Commander Colin M. Jones of the Navy Experimental Diving Unit in Washington, D. C., who was in charge of the operation, selected on the basis of available information a series of eleven locations to be investigated by the Seaprobe to test the ship's undersea search and identification capabilities.

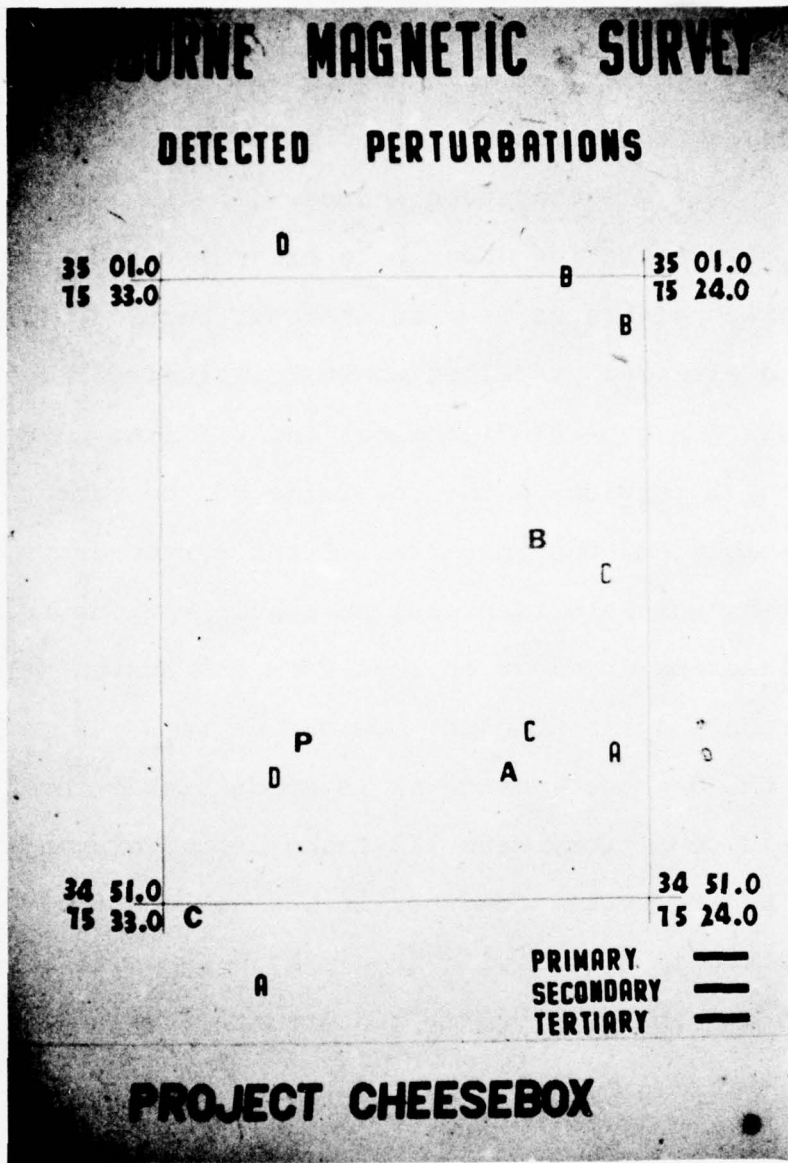
The expedition got underway from Morehead City, North Carolina on 31 March. The evaluation team included members from the Naval Research Laboratory, the Naval Academy, Naval Research and Development Center, Duke University, the National Geographic Society, and the State of North Carolina. The ship arrived over the coordinates of the first site at 0800, 1 April but it took six hours to refine the fix and position the Seaprobe over the wreck.

More than 1500 photographs and several video tapes were made of the wreck before stormy seas and turbid waters ended operations and prevented any attempt to recover artifacts. The study of these tapes and photographs enabled the Navy-Duke-North Carolina team definitely to identify the wreck as being the remains of the Monitor.

The hulk of the vessel is resting bottom-side up on the ocean floor in 210 feet of water. Roughly a fourth of the turret is visible protruding beyond the armor belt, as it

must have sheared off the deck when the ship sank to the bottom. A photomosaic of the hulk was assembled from the photographs and the following distinguishing characteristics were noted: (1) bow and stern shapes, (2) direction of the plating, (3) distinctive armor belt clearly visible, (4) peculiar diagonal braces used in the construction, (5) shape of skeg and extended propeller shaft position, (6) overall size of hull and general dimensions and (7) flat bottom. In addition, a portion of the underside of the turret was clearly visible and the thickness of the turret armor and turret dimensions were identical to specifications from original engineering drawings on loan from the Stevens Institute of Technology in Hoboken, New Jersey.

From the data collected, it is evident that the hulk is in a fragile condition, with 112 years of submersion in salt water taking its toll. However, it was noticed that the armor belt, constructed of oak with iron plating, was in surprisingly good shape and that the turret, constructed entirely of iron, was still intact.



Airborne Magnetic Survey Results of the 17 January 1974 Flight. Courtesy W. J. Andahazy



Commander Colin M. Jones, USN, Officer-in-Charge, Navy Experimental Diving Unit and the Alcoa Seaprobe Expedition and Dr. Andreas Rechnitzer, Deputy Oceanographer of the Navy.



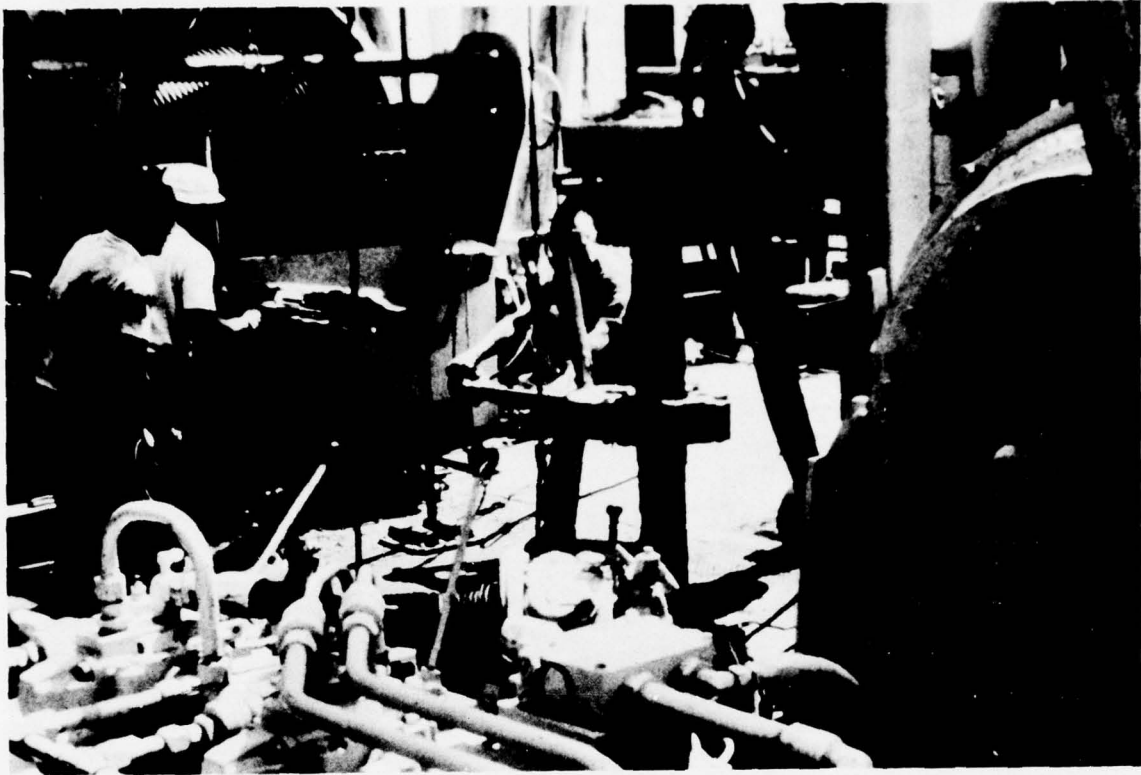
Mr. Chester L. Buchanan, Naval Research Laboratory Helped Supervise the Underwater Survey Work of the Alcoa Seaprobe. He Brought With Him Valuable Experience Gained Aboard the Mizar in the Thresher and Scorpion Operations. His Professional Assistance is Gratefully Acknowledged.



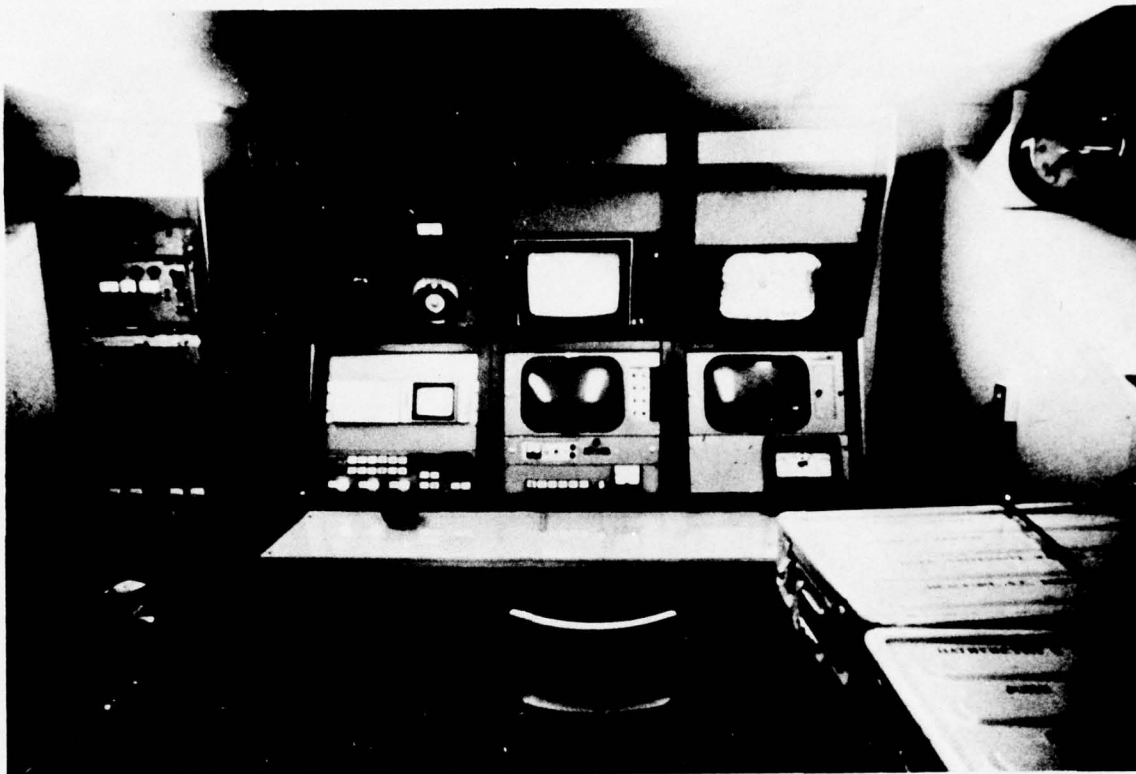
Seaprobe Concept Showing the Cycloidal Propellers, Fore and Aft and the Semi-rigid Drill Pipe String Being Lowered from the Deck Mounted Derrick, Lowered through a Center Well in the Ship's Hull to the Ocean Floor and the Survey Site.



The Drill Pipe String is Raised into the Derrick by the Multi-ton Coupling.



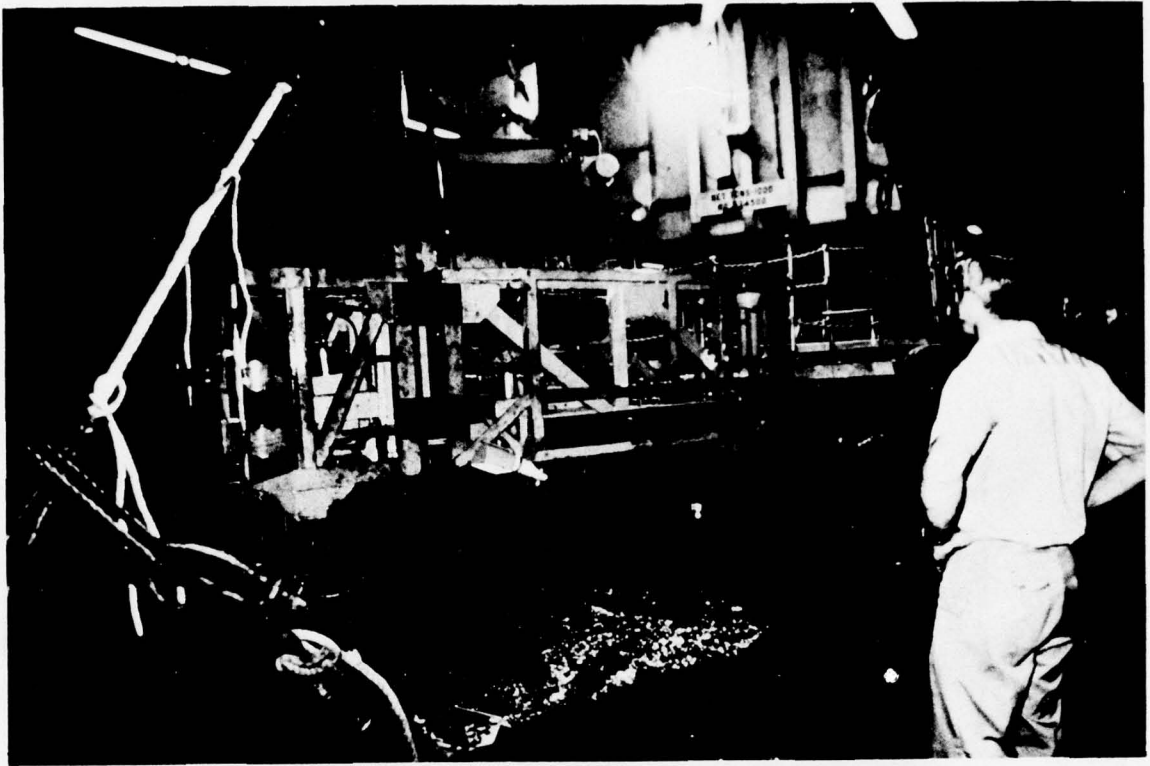
The Deck "Apes" Man-handle the Pipe Sections, Directing  
the Mechanical Manipulators as They Screw the Pipe Sections  
Together.



Evaluation Console Below Decks in Search Central  
Where the Scientific Party First Viewed the Wreck  
of Monitor from the Alcoa Seaprobe.



The Deck Crew Stands by for Orders from Search Central Adding to or Reducing the Length of the Pipe String.



Instrument Pod Raised into the Well Deck of the Alcoa Seaprobe.  
The Instrument Pod is a Steel Frame Which Carried all the  
Search, and Photographic Equipment for the Operation.



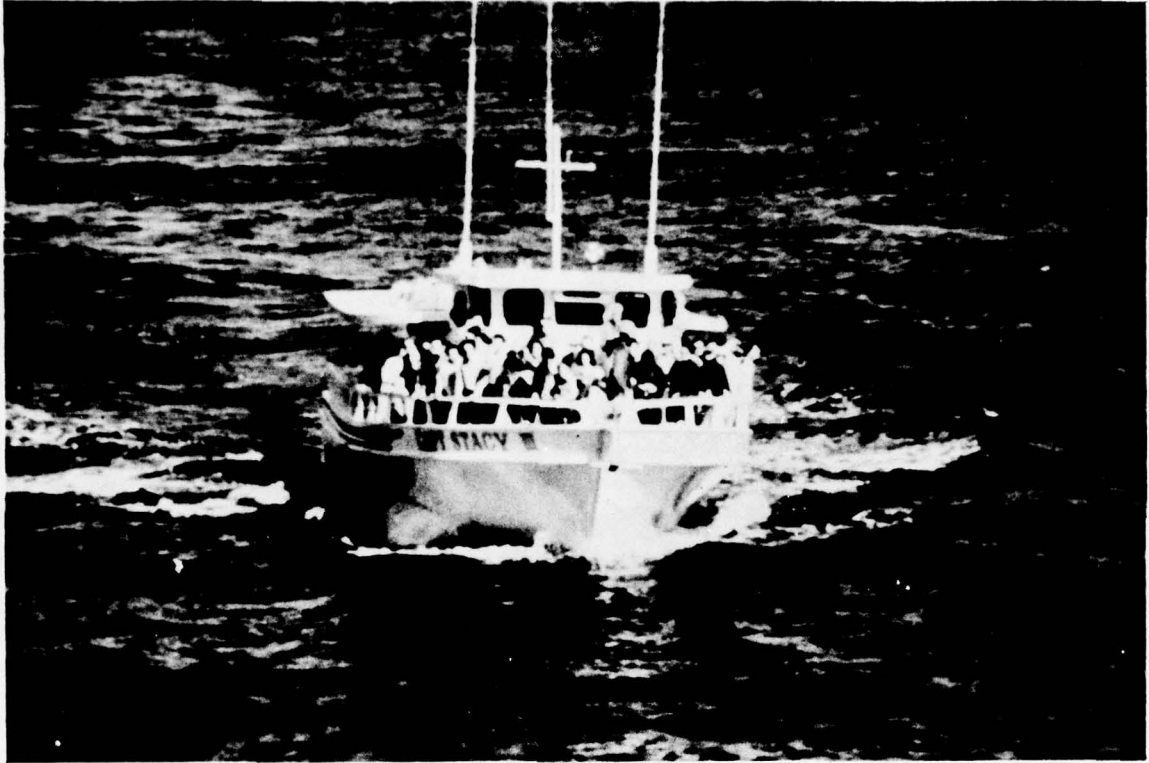
Members of the Expedition on Deck of the Alcoa Seaprobe.  
(L to R, Dr. Kent Schneider, State of North Carolina;  
Mr. William J. Andahazy, NSRDC; Mr. Chester L. Buchanan,  
NRL; Mr. John Newton, Duke University and Commander Colin  
M. Jones, Navy Experimental Diving Unit)



The Tedious Work of Logging-in and Studying the Photographs Consumed much of the Evaluation Party's Time. Shown are Mr. E. W. Peterkin (NRL), Mr. Nathan Benn (National Geographic) and Mr. William J. Andahazy (NSRDC).



An Attempt was Made While on Board the Seaprobe to Assemble a Photographic Mosaic of the Wreck. Shown is Miss Dorothy Nicholson of the National Geographic Society.



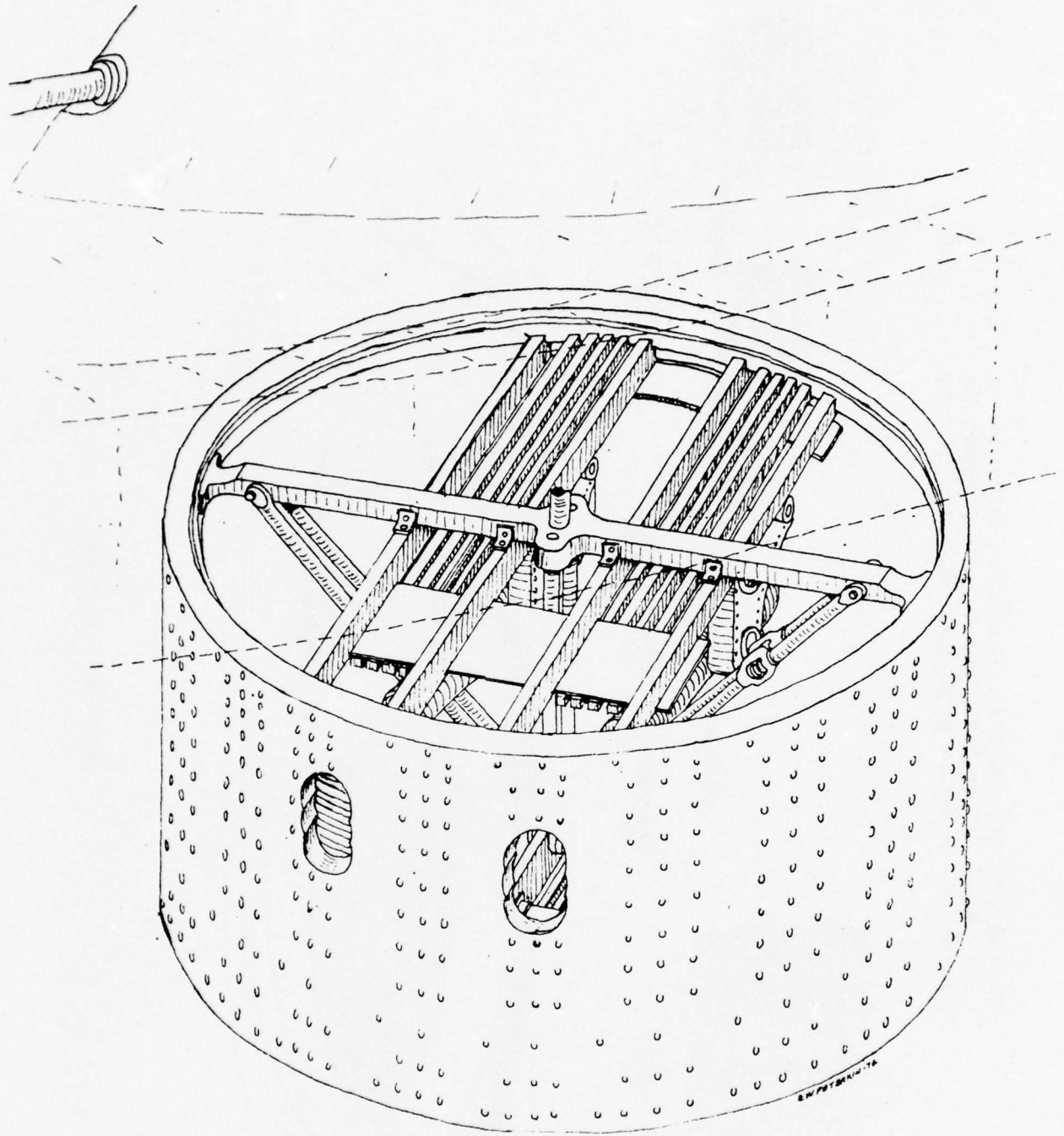
In the Middle of the Week's Operation the Captain Stacy III Loaded with Representatives of the Press Visited the Alcoa Seaprobe at Sea.



Mr. E. W. Peterkin and Mr. W. J. Andahazy Discussing an Artist's Conception of the Wreck.



Some of the Members of the Evaluation Team Aboard the Alcoa Seaprobe at the Termination of the Week. (L to R, Mr. Ed Jaekel, Duke University; Dr. A. Rechnitzer, OPNAV; Mr. E. W. Peterkin, NRL; Miss D. Nicholson, National Geographic; Dr. K. Schneider, State of North Carolina; Cdr. C. M. Jones, OCE; Mr. J. Broadwater, North Carolina; Miss S. Belock, Duke University and Mr. G. Watts, State of North Carolina) Note the Dazed Looks after a Week at Sea Studying the Wreck Photographs.



Drawing by Mr. E. W. Peterkin from original engineering drawings, of the Monitor turret inverted protruding from side of armor belt.





Final U. S. Navy photographic mosaic of the wreck of the Monitor. It took more than four months for photographic experts to assemble from the more than 1200 photographs that were taken on board the Seaprobe. The arrow points to the turret displaced to the stern and outboard of the wreck.

NAVY EXPERIMENTAL DIVING UNIT  
BLDG. 214, WASHINGTON NAVY YARD  
WASHINGTON, D. C. 20374

EXPERIMENTAL DIVING UNIT REPORT

12-74

EVALUATION OF ALCOA SEAPROBE

by

CDR COLIN M. JONES, USN

Distribution limited to U.S. Gov't agencies only; test and evaluation; ( ). Other requests for this document must be referred to the Officer in Charge of the Navy Experimental Diving Unit.

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#### ABSTRACT

An evaluation of the ALCOA SEAPROBE was conducted to determine the capabilities of this vessel to perform an ocean search for bottom targets, and upon acquisition of a target, to adequately identify the target and to recover pieces of the target. The vessel has a unique maneuvering capability which enables the vessel to hover or move in any direction in the deep ocean without the use of external mooring facilities. This is accomplished using two Voigth-Schneider propulsion units, one forward and one aft. The vessel has a marginal capability to perform search and a good capability for photography and video observation of the ocean bottom. No tests were conducted of the ability of the ship to recover objects from the ocean floor due to poor weather. The fundamental limitations of the SEAPROBE are that in the search mode, the ship is unable to search at speeds much in excess of 1 knot. In addition, the vessel is not able to perform satisfactorily in sea states in excess of a State 4 (winds above 25 kts). However, in good weather the unique maneuverability of the SEAPROBE provides an extremely stable platform which can be placed over a target area with relative ease and the ship can maintain this position using either an ocean bottom pinger or some other precision navigation system.

These capabilities should not be overlooked in the event of a requirement for deep ocean search and recovery operations, especially in areas where relatively good sea conditions can be anticipated.

## SECTION I. Definition of Evaluation Parameters

1. The ALCOA SEAPROBE represents a new concept in deep ocean search and recovery. In order to evaluate the real capabilities of this vessel, in a search and recovery operation, funds were allocated and a program was devised with the objective of searching for and finding a target on the ocean bottom, photographing this target in complete detail and then recovering some parts.
2. The desired characteristics of the test site were as follows:
  - a. Should be on the east coast of United States to minimize transit time for SEAPROBE.
  - b. Should contain numerous wrecks.
  - c. Should have at least one wreck of known origin.
  - d. Should if possible include at least one wreck about which information is of potential value.
3. The site selected was a 10 square mile area 25 miles southwest of Cape Hatteras. This area had recently been searched for magnetic objects by the NSRDC, Annapolis, MD, as an outgrowth of a project they had developed, in conjunction with a group of midshipmen from the Naval Academy, to survey numerous wrecks in the Cape Hatteras area. Navigation Data was by LORAN C. This survey had resulted in the detection of eleven magnetic contacts judged to be wrecks.

One of these magnetic contacts coincides in position with a site recently explored by Dr. Edgerton of MIT and a group headed by Mr. Newton of Duke University. This wreck was claimed to be the famed ironclad "MONITOR".

Subsequently a request was received from Dr. Edgerton for Navy assistance in verifying this wreck. In addition, the Duke University group agreed to provide and install a precision ranging system (Del Norte Precision Navigation System) and negotiated with the National Geographic Society for supplemental funding of \$20,000 to cover the additional effort required to fully document the site if it was verified to be the Monitor.

4. The ALCOA SEAPROBE is a dynamically positioned floating work platform. The ship can be precisely navigated for fine grain searches and is designed to hold a fixed position in the ocean against winds and currents with the aid of the following on board systems:
  - a. Acoustic Ship Positioning System (ASPS).
  - b. Radar positioning relative to land-based or moored reference points.

In addition the vessel has adequate space and power to install additional equipment such as:

- a. Land-based precision short range and medium range radio location system.
- b. World wide positioning systems employing satellites and/or VLF omega.

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

5. A pair of Voigth Schneider propellers-one at each end of the ship, permits precision control and positioning of the sensor packages, recovery mechanisms, viewing or recording systems and real time television for examination of deep ocean objects. In the search mode, the basic search pod deploys a side scan sonar designed to sweep a 2400 foot path along the sea floor. The pod also includes forward looking sonar, television, still camera, target illumination systems, and a dropable acoustic beacon for use in marking specific target locations.

## SECTION II. Operation Evaluation

1. It must be noted initially that the operation commenced without the benefit of the Del Norte Precision Microwave Transponder Ranging Navigation System. This failure was not the fault of the SEAPROBE, but grew out of a misunderstanding with the parties who had agreed to provide this equipment. The Del Norte navigation system was ultimately delivered by the U.S. Marine Corps helicopter on Wednesday, the third day on site.

2. Immediately upon arriving in the vicinity of Site 1 at 0815 Monday morning, fathometer contact was made with the wreck. However, at this time the pod was not in the lowered position and there was no capability to put out a marker buoy or drop a marker pinger. As a result, contact with the site was not regained until 1605 Monday afternoon.

3. The areas investigated were as follows:

<u>Targets Investigated</u>	<u>Remarks</u>
1. Latitude 35°0.18 minutes North Longitude 75°24.4 minutes West	USS Monitor
2. Latitude 35°54.7 minutes North Longitude 75°24.4 minutes West	Found no wreck
3. Latitude 34°53.3 minutes North Longitude 75°30.5 minutes West	Found no wreck

4. Equipment:

- a. Instrument pod, two televisions, one still camera, left/right side looking sonar, forward scan sonar.
- b. LORAN C
- c. Del Norte Microwave Transponder Ranging System added during evaluation. (Wed AM)
- d. Fathometer
- e. Photo processing and copying equipment
- f. Television and video recording equipment

5. The search sensors are attached to a universal steel framework that can be clamped to the drill pipe. Additional lengths (40 or 60 foot of pipe) are then added above the length of the drill pipe which the sensor framework has been clamped and the entire assembly is lowered into the water in 40 or 60 foot increments. The entire cable to the sensor pod is used regardless of the amount of pipe employed. The sensors employed in the initial search were:

- a. Side scan sonar, left and right. (Chesapeake Instrument)
- b. Two pan and tilt television cameras. (Hydro Products)
- c. One fixed 35 mm camera (EG&G)
- d. One forward scan sonar. (Straza)
- e. Two 250 watt thallium iodide flood lights for television lighting. (Hydro Products)
- f. A system fo strobe lights for use with the photographic camera. (EG&G)

The pod which is equipped with a compass and readout to the vessel was normally oriented fore and aft to match the vessel. This puts the forward scan sonar looking forward and the left and right side scan sonars illuminating and receiving normal to the port and starboard side of the vessel.

The side looking sonar records the height off the bottom continuously. However, this has poor resolution. This presented some difficulty inasmuch as great care must be exercised in lowering the search pod to insure that it is not rammed into the bottom. Once visual contact with the bottom has been made, normally, use is made of this visual contact to insure that the pod is kept off the bottom. A flexible 8-foot rod was suspended below the pod to serve as a visual guide for distance to the target and guide the close approach of a target while photographing.

Great care was exercised by all concerned in insuring that adequate distance off the bottom was maintained at all times. The effect of ship's rise and fall due to sea state was minimal in the vicinity of the well-deck which is located midship and it did not appear that the camera was bouncing up and down more than perhaps a foot despite the fact that 3 and 4 foot seas were running.

Upon initially lowering the pod, TV viewing range and visibility was unexpectedly good. On occasion the bottom could be seen from a distance of as much as 25 to 30 feet.

Once the search pod was placed in the water, the ship was then forced to maintain its speed at approximately 1 knot or less in order to keep the arc of the pipe string and pod within the allowable limits. This limits the search rate and although the side looking sonar was claimed to provide approximately a 2400 foot swath of detection, great difficulty was experienced in both acquiring and reacquiring the target. See Appendix A for the summary of search.

Plankton drifting past the camera appeared to block the viewing range of the TV cameras at times; however, whenever a high contrast target on the bottom appeared, the scatter caused by the plankton was not so pronounced. This is probably due to the normal mental integration and accommodation of the viewer rather than a decrease in the plankton concentration.

The search control center is supplied with three primary sets of TV monitors for each of the two TV cameras. An additional pair is located on the bridge. The TV cameras were always on line and the output is satisfactory for small area search and classification. The video quality was generally good.

The video signal was noted to be periodically degraded by two factors: (1) the electrical current required to charge the strobe capacitors caused horizontal streaks in the video; and (2) the light from the flash of the strobe blanked out the video for more than a second after each flash. Therefore, simultaneous acquisition of high quality video recordings and photography for developing permanent records are not compatible. To acquire good video recording it is necessary to cease photography. It might well be that better quality photography could be produced by securing the video lights; however, this was not tried since video was the primary input used by the mate in determining the steering and movement of the ship.

The precision depth recorder (fathometer) provided a good profile of the sea floor and a good profile for target detection. Use of the fathometer for a search tool should be emphasized.

No targets were observed on the forward scan sonar.

The side looking sonar gram showed high resolution of the Monitor, sand waves, and rock outcrops, at short ranges.

Nevertheless, whenever the search operator lost visual contact, target reacquisition did not appear to be assisted markedly by the side looking sonar, probably due to the fact that the target was within the insonification shadow zone beneath the pod.

The present method of deploying the acoustic transponder is to selectively place it on the sea floor by releasing it from the pod. Once this is done, by following the transponder indication on the Acoustic Ship Positioning System (ASPS) CRT visual readout, the search operator was able to hold the ship's position more effectively. He also was able to regain visual contact with the target more expeditiously since he had a reference on the bottom. A shortcoming of this acoustic transponder is its limited horizontal detection range by the ship's four hull mounted hydrophones. The inverted cone projection pattern limits horizontal detection to approximately 100% of depth, for example, 210 feet of seawater provides a 210 foot radius at the surface. This is a fairly tight limit for shallow water search in rough seas and high wind and current.

The 35 mm EG&G camera provided over 1500 high quality vertical view photographs. Of these approximately 1200 were black and white, the remainder color. The availability of a single camera precluded simultaneous acquisition of color and black and white or vertical plus oblique angle views. Additional cameras for such use and backup would provide a more complete capability, and would eliminate the need to wait until the single camera could be removed to the dark room, unloaded, and reloaded after each run.

Shipboard processing of the black and white photography made it possible to complete onboard working photographs and determine whether the photographs were of adequate quality for the task at hand. On board color processing was limited. There is no automatic printing or enlargement capability aboard.

6. There is no onboard capability for magnetic detection. This proved somewhat unfortunate since the primary targets had all been initially determined by magnetic survey, using airborne magnetic detection equipment.

7. LORAN C is the most accurate navigation system normally aboard. Position fixes were observed to shift in excess of a quarter of a mile at sunset. The accuracy of the system was far too coarse to permit return to a target for assured visual contact. The first two days of operation, without the Del Norte microwave system, revealed the inadequacy of the regular complement of equipment, that is radar, LORAN C, Sextant, etc. for establishing a precise location of a sunken target. The Del Norte system provided accuracy to within a few feet and was repeatable.

The Honeywell Acoustic Ship Positioning System (ASPS), one put into service, provided an excellent short baseline reference point for maneuvering the SEAPROBE and the sensor

pod over the Monitor. However, as indicated the effective radius for maintaining an automatic lock-on is 100% of the water depth. This is shown to be difficult in a heavy sea and under high wind conditions. The expensive acoustic beacon (approximately \$5000) was not deployed until the Captain of the SEAPROBE was satisfied that he could place it in close proximity to the wreck and recovery of the unit would be assured. He was subsequently not able to pick up the beacon due to rough seas. When he later returned to the site to pick up the beacon, it had ceased emission and locating and recovery of the beacon is reported to have taken approximately eight hours.

8. The two Voight Schneider propulsion units, one located in the bow and the other in the stern provided outstanding dynamic positioning of the vessel and the search pod. The automatic pilot control in the ship's head is a constant. Heading was usually into the sea. The ship's position is manually steered using a joy-stick located on the bridge with a duplicate in search control. Ship and pod translation is simple for the operator with vernier accuracy even in a State 2 to State 3 sea. Observing the target on the TV monitor, the helmsman or search operator could hold a position within a foot or two, or at his choosing, cruise the pod along the target in any direction as he wished. If the target dropped from sight, there was a demonstrated initial difficulty in reacquiring the target. However, once its features were well understood (from onsite experience) and when the acoustic ship positioning beacon was implanted, the performance was dramatically improved and coverage was available on demand. See Appendix A for the search summary.

9. To summarize the search and photography that was accomplished, approximately 1200 black and white photographs and 450 color photographs as well as in excess of 4 hours of video tape recording were made of the Monitor site. This was accomplished Monday night, Tuesday and Tuesday night, with the last color photography completed about 0500 Wednesday. Wednesday night was spent searching at Site 2 and then Site 4 with no target located at either site.

By noon Thursday it was apparent that we did not have full coverage with our black and white photographs of the wreck at Site 1. The ship returned to Site 1 and at that point the weather worsened and we were unable to conduct any further photography. In fact, we were not able to place the pod back in the water.

### SECTION III. Evaluation Summary and Recommendations

1. The ship does not have as normally configured, an adequate ocean search capability. The normal search capability involves using side scan and forward scan sonar on the pod. In this mode, the ship is limited to approximately 1 knot through the water. In deep water this speed might be even more drastically reduced. In addition to the inability of

the SEAPROBE to function satisfactorily in this search mode, once a target was acquired, considerable difficulty was experienced in staying with the target, although the maneuverability of the ship is phenomenal. The difficulty arose when the ship drifted slightly off the edge of the target. As soon as the target was out of visual contact, it was difficult for the operator to regain visual contact. With the use of the acoustic ship positioning system, this problem can be minimized. However, a better reference, either with a precision navigation system or a wider area coverage acoustic ship positioning system is needed.

2. The ship is not routinely equipped with a precision navigation system and does not have a doppler sonar navigation system. Some system is needed for establishing a precision grid at the worksite. In summary, the SEAPROBE is basically suited to shallow water search and recovery but needs additional equipment to be effective. The most useful additional equipment would be precision navigation equipment and a towed-fish with side scan sonar and magnetometer for search. Available hardware could easily be integrated into the present configuration to overcome these difficulties. The ship's stern is configured with a ramp which would lend itself very nicely to launching and recovering such a towed fish. The towed fish could also be equipped with magnetic sensors and could well provide a search capability equal to that of almost any other ship available.

3. The ship's crew was not particularly experienced in the business of photomapping targets and initially a few mistakes were made in the techniques of operating the cameras and coordinating the ship's movement. As a consequence, putting together the composite pictures will be a more significant job than it otherwise needed to be. However, this difficulty would be overcome with more experience.

4. The ship has a unique ability to maneuver. It can go in any direction up to the limits of its propulsion system against tide, wind and current. The ship is presently limited to approximately 7 knots ahead.

5. The ship provides an ideal work platform for an open sea site since it can hold position without putting out any mooring anchors. This provides a deep water mooring capability instantly.

6. The ship functioned well. The personnel aboard the ship worked well together as a team and the ship has, as previously noted, outstanding maneuverability. Unfortunately, the SEAPROBE is somewhat underpowered which places a limitation on the wind and current that she can hold position against, and this factor must be kept in mind when planning operations in areas of significant current, or during periods of expected bad weather.

APPENDIX A

Search Summary

FIRST DAY - 1 April 1974

0842 Vertical sonar contact

0900 Pod down and search underway

1114 Target detected on SLS starboard side

1407 Target detected on SLS port side

1605 First visual contact of target (USS MONITOR)

Note: An interval of 7 hours 23 minutes from initial contact to first visual contact.

2120 Pod down and operating

Minutes

On   Off   2230 Contacted target visually

1            2231 Off target

19           2250 On target

5            2255 Off target

15           2310 On target

1            2311 Off target

96           0047 On target

23           0010 Off target

7            0017 On target

19          0136 Pulled pod

49   137

26% On   74% Off

Note: Reacquisition time is inefficient after loss of visual contact without acoustic beacon aid and on-target experience data.

## APPENDIX A (contd)

2 April 1974Minutes

<u>On</u>	<u>Off</u>	
		2010 Probe lowered
		2106 Off target
	17	2123 On target
2		2125 Off target
	9	2134 On target
12		2146 Off target
	1	2147 On target
6		2153 Off target
	1	2154 On target
3		2157 Off target
	4	2201 On target
5		2206 Off target
	2	2208 On target
12		2220 Off target
	1	2221 On target
5		2226 Off target
	3	2229 On target
	10	2242 On target
10		2252 Off target
<u>173</u>	<u>—</u>	0025 Terminated
233	48	
83% On		

APPENDIX A (Contd)

Note: Time on target markedly improved (83% vs 26% earlier). Acoustic beacon still not in place and Del Norte precision navigation aid not yet in service. Once these two aids were added the on target time rose to nearly 100%.

APPENDIX B

Operation Plan

1. Objectives

Primary

(a) To determine the characteristics, capability, and efficiency of the SEAPROBE in operations involving inspection and documentation of shallow wrecks.

Secondary

(a) To inspect and obtain photographic documentation of 11 magnetically located wrecks near Cape Hatteras.

(b) In the event one of these hulks is the Naval Vessel Monitor, a special effort is required to insure the acquisition of full-high quality photographic coverage suitable for the production of a montage for public display.

2. Facilities Involved

ALCOA Marine Ship - SEAPROBE

3. Schedule

Depart Moorehead City, N. C.	31 Mar 74	AM
Arrive Site #1 Operation Area	31 Mar 74	
Depart Operation Area	7 Apr 74	
Arrive Moorehead City, N. C.	7 Apr 74	

Schedule may be adjusted as deemed necessary by the Officer in Charge of the Expedition (OCE).

4. Areas of Operation

There are 11 specific targets to be investigated. The order of investigation will be as listed below:

Site #1	Lat	35°00.1'N	Lon	75°25.0'W
Site #2		34°54.7'N		75°24.4'W
Site #3		34°58.2'N		75°24.6'W
Site #4		34°53.3'N		75°30.5'W

Site #5	34°46.0'N	75°31.0'W
Site #6	35°01.0'N	75°25.0'W
Site #7	34°54.6'N	75°25.9'W
Site #8	35°02.4'N	75°29.1'W
Site #9	34°52.6'N	75°26.8'W
Site #10	34°57.2'N	75°26.4'W
Site #11	34°50.7'N	75°32.3'W

5. Equipment/Supplies Required

Equipment:

- (a) Instrument Pod with TV and still cameras
- (b) LORAN C and SATNAV
- (c) Fathometer
- (d) Photo Processing (to negative)
- (e) Photo Processing (to positive)
- (f) Photo copy (to scale)
- (g) Light table
- (h) Layout table - at least 4' x 8'

Supplies

- (a) Tri X or equal film - 30 rolls (150')
- (b) Positive Duplicating film - 30 rolls (150')
- (c) Copy camera film
- (d) Masking tape - 10 rolls
- (e) Rubber cement - 10 bottles
- (f) White paper 24" wide - 100' roll

6. General Operating Procedure

Hulk Location:

Initial contact will be attempted by searching the area by fathometer. Parallel passes at 100' intervals expanding from

the assumed wreck position will be made to a distance of 1000 feet. The direction of the baseline will be selected on the basis of weather and ship handling characteristics. Speed will be selected for best bottom display - approximately 3 knots.

If the above method of operation is not successful, the same area will be searched using the side scan sonar. The best speed for operation of this equipment will be used (assume 1-2 knots).

If the side scan sonar method of operation is not successful, the same area will be searched using the TV system. This will be done at the best TV speed (approximately 1 knot). The pattern will be an expanding box centered at the assumed wreck site. If weather or other factors do not favor this pattern, alternatives will be sought.

#### Documentation of Hulk:

When the hulk has been located, the still cameras will be operated at maximum rate and the ship will maneuver using the TV as a guide to completely photograph all portions of the wreck plus the area immediately adjacent to it. The photoheight will be adjusted to the best tradeoff between coverage and image quality. A desirable height is 11 feet.

#### Hulk Site Identification:

When the film in the camera pod is completely expended, a buoy shall be launched to mark the wreck location.

#### Transit to new site:

When the pod is retracted, the ship will proceed to the next site, and will commence to search as in (Hulk Location above). When the hulk is located the procedures of (Documentation of Hulk, Hulk Site Identification and Transit to new site) will be repeated.

#### Re-examination of Hulk:

After the photographic documentation has been reviewed for a hulk, a determination will be made as to the necessity for additional photo documentation or object recovery. If either of these requirements exists, the ship will revisit the appropriate site, and re-photograph or recover objects as required, at the completion of the current documentation underway.

#### Area Clearing:

When it has been established that no further documentation of a hulk is desired, and that an adequate refined position has been established, the moored buoy will be recovered during the next site change evolution.

### Completion:

When all hulks have been fully documented, or when necessary to depart to reach port by noon, 7 April, or if weather dictates discontinuation, the ship will depart the area. All moored buoys will be removed before final departure.

### 7. Supporting Personnel

A number of people will supplement the regular operating personnel. These are selected to supply specialized expertise and experience in one or more of the areas of effort involved. These persons will be divided into teams and will be made responsible for analysis of the documentation and will make recommendations to the OCE.

CDR C. JONES	NAVXDIVINGU	OCE
Ernest	PETERKIN	NRL
Edward	MILLER	Naval Academy
Chester L.	BUCHANAN	NRL
Andrew	RECHNITZER	OPNAV
Gordon	WATTS	North Carolina
John	NEWTON	Duke University
Dr. Harold	EDGERTON	MIT
Dorethy	NICKOLSON	Natl. Geographic
Archie	GALLOWAY	CHINFO
Nathan	BENN	Natl. Geographic
Sandra	BELOCK	North Carolina

### 8. Communications

Communications to shore activities will be handled via the standard ship-shore radio-telephone system. No information is to be released to the news media without permission of the OCE.

## NEWS RELEASE

Features known to be part of the Union iron-clad MONITOR were identified last week during a Navy evaluation of shallow water search capabilities of the research vessel ALCOA SEAPROBE. Search operations were conducted from SEAPROBE, under contract to the Navy from March 31st to April 7th off Cape Hatteras, N. C.

The area, known as the graveyard of the Atlantic, contains several wrecks which served as targets for SEAPROBE's acoustic and visual detection and identification equipment. In use, the gear is lowered to the sea floor on the end of a typical offshore oil well drilling pipe "string."

The first site searched last week was the site claimed by a team from Duke University last summer to be the location of the MONITOR. Using SEAPROBE's unique dynamic stationkeeping and maneuvering capability, scientists recorded the scene by way of an instrumentation pod with real-time television and still cameras, during numerous systematic passes over the hulk. Mr. John Newton, Marine Superintendent of Duke's Marine Laboratory at Beaufort, N. C., and Mr. Gordon Watts, a representative from North Carolina Department of Cultural Resources, confirmed that the hulk of the vessel was the one they claim to be MONITOR.

Over 1200 photographs and several video tapes were made of the hulk before stormy seas and turbid waters hampered operations and prevented any attempt of recovering artifacts

for fear of disturbing the hulk. The photographs and video tapes enabled Navy, Duke and North Carolina experts to confirm prominent features known to be part of the MONITOR.

Roughly a fourth of the famous "cheese box" turret is clearly visible and protruding from the armor belt. A photo mosaic of the bottom of the turret has been constructed and compared to an ink drawing drawn from the ship's original blueprints. The turret was dislodged from its original position in the center of the vessel when it turned upside down on its way to the bottom. An inner support member of the turret is visible in the mosaic.

The anchor well, located under the bow, is evident. An extended keel, unique to the MONITOR, is visible and heavily encrusted with marine growth. Numerous gaping holes in the bottom of the hull allow views into the craft where exposed ribbing and debris can be seen despite a layer of sediment deposits.

Other features identified include bow and stern shapes, cross section of the hull, direction of the plating, shape of skeg and propeller shaft position, construction and depth of the armor belt, extremities of diagonal bracing, overall size of hull, flat bottom, spacing of frames and angle iron inside armor belt.

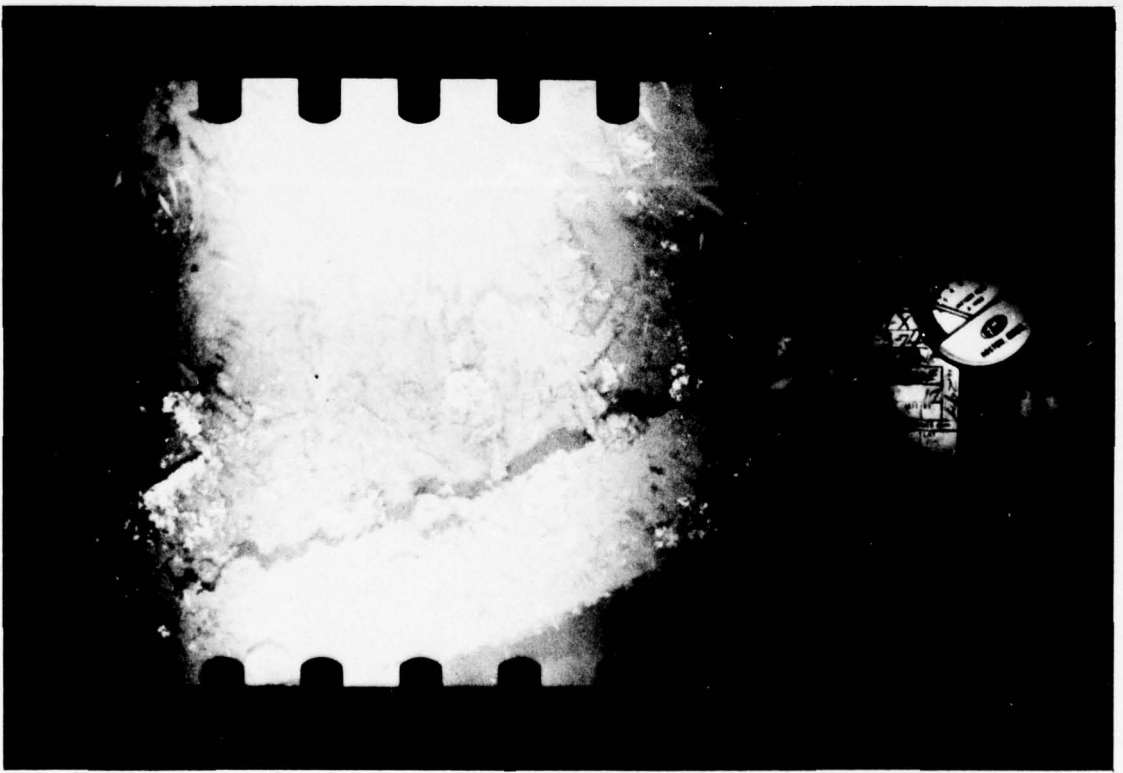
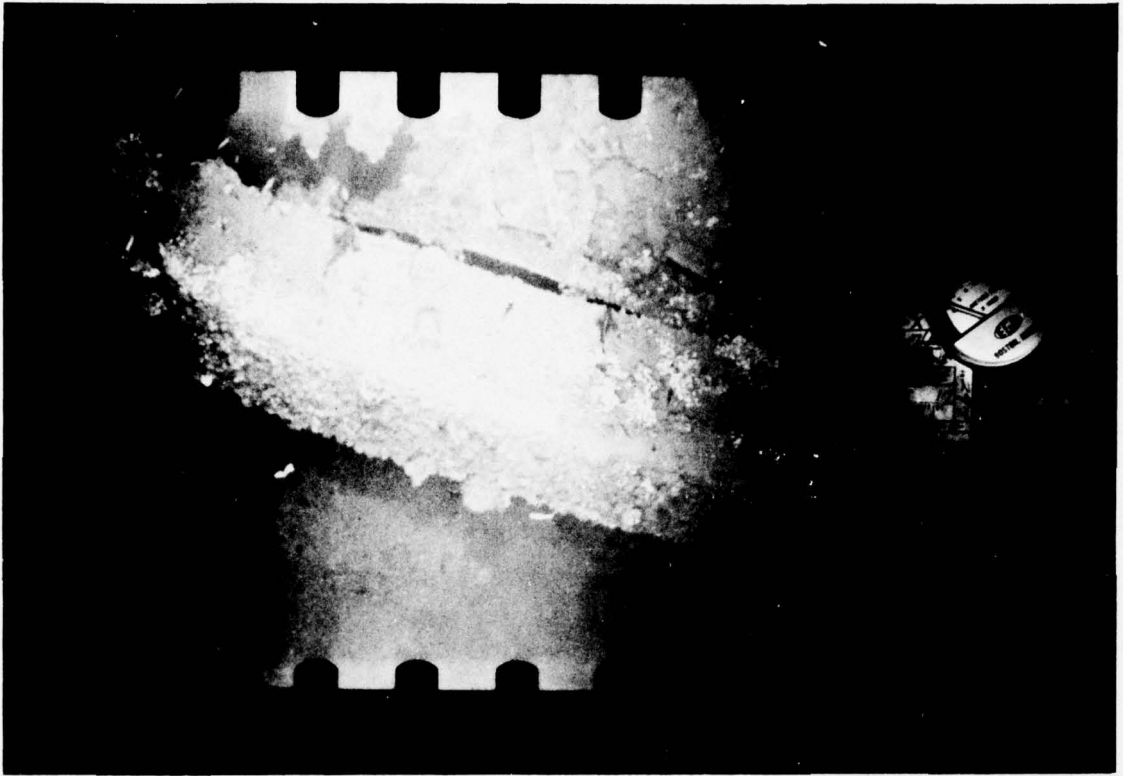
In addition, historical evidence indicates that the MONITOR sank in the immediate search area.

SEAPROBE searched two additional wreck sites on Wednesday

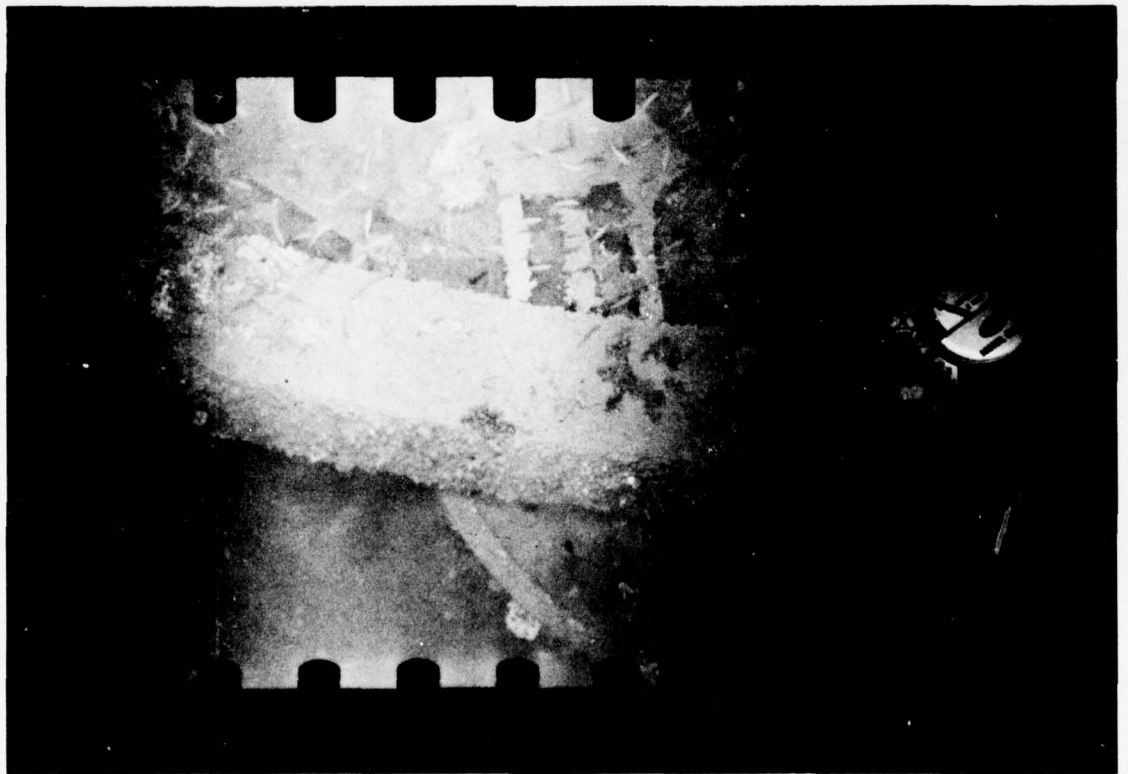
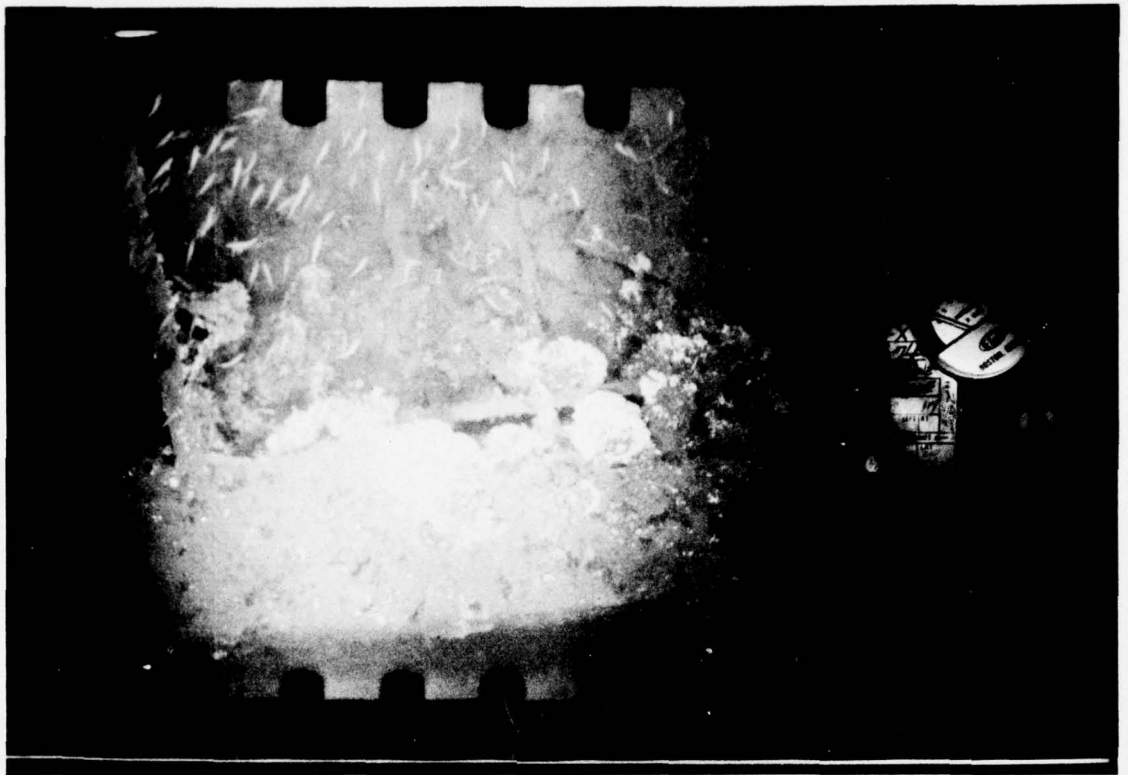
and Thursday while photographic and video tape evidence were being analyzed. The weather deteriorated, however, preventing identification of the wrecks. On Thursday evening SEA-PROBE returned to the MONITOR site. She remained on that site until Saturday evening, but surging seas prevented lowering her instrument pod.

The Navy has no plans for additional search operations over the site.

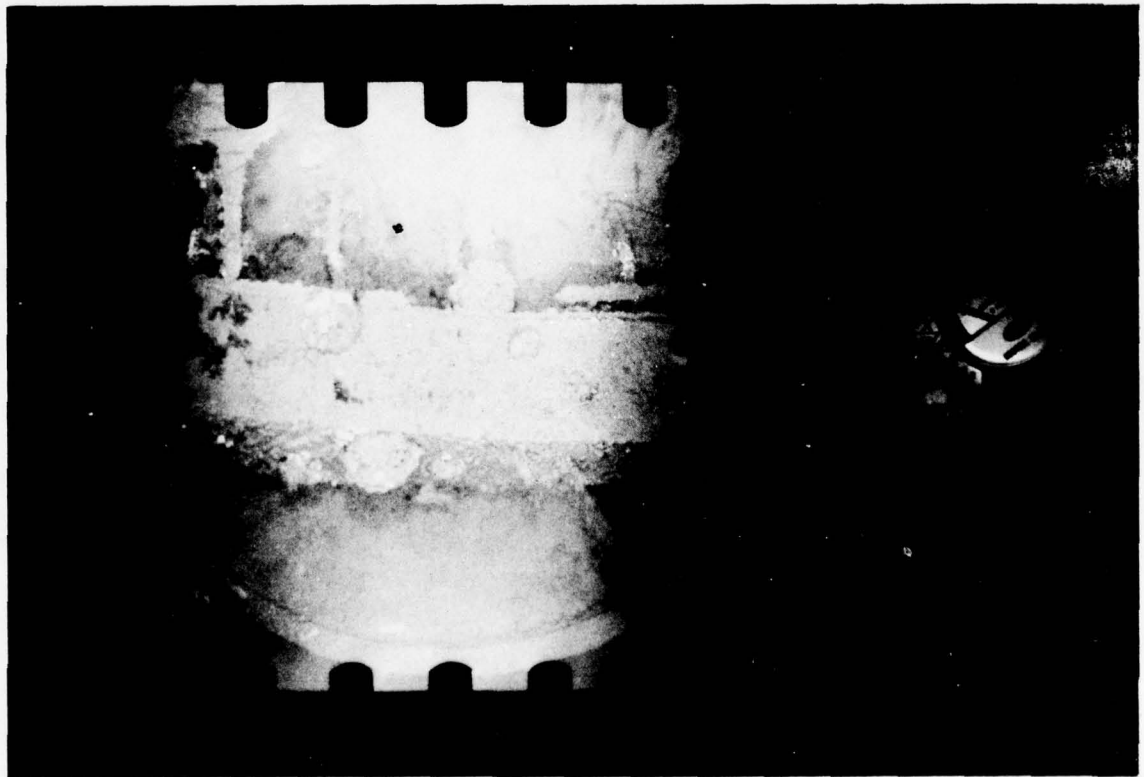
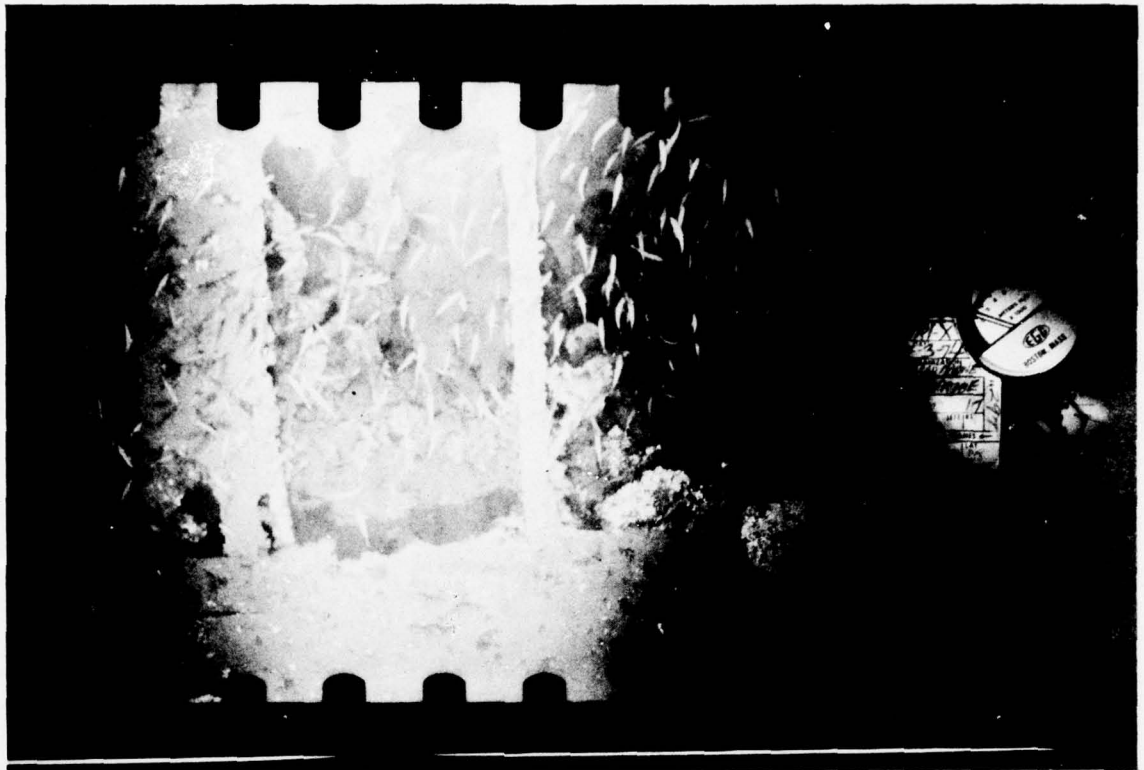
Chinfo News Release  
7 April 1974



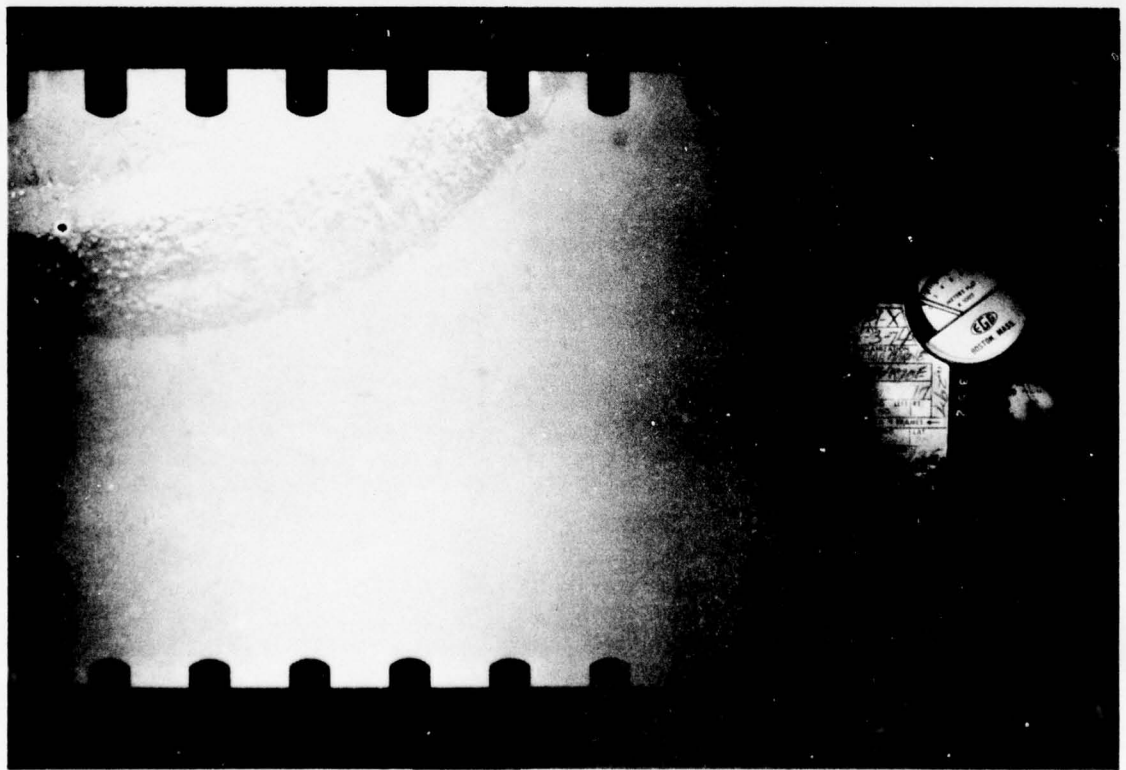
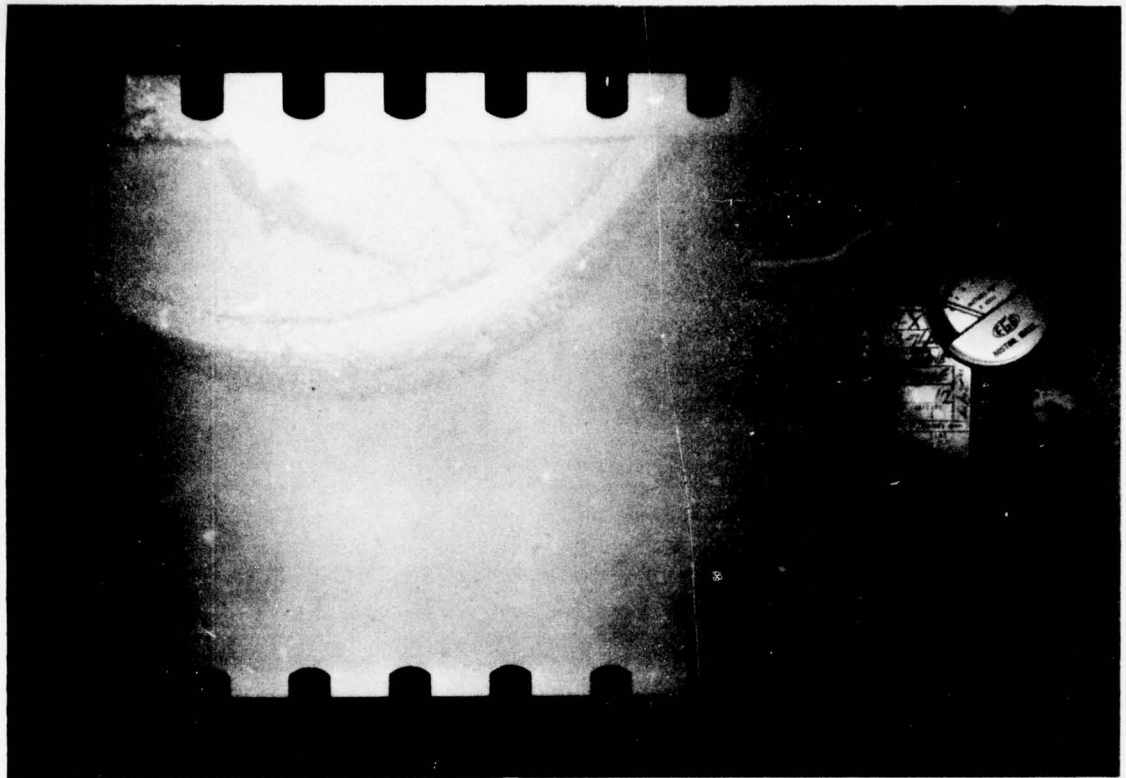
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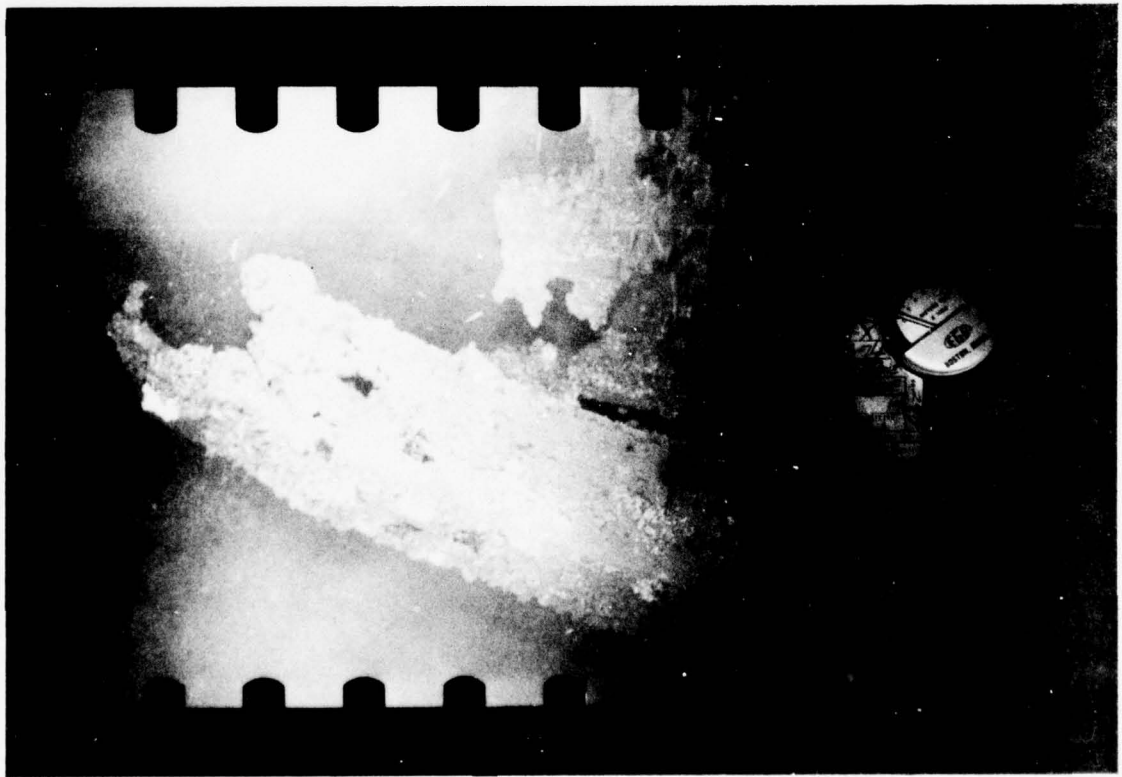
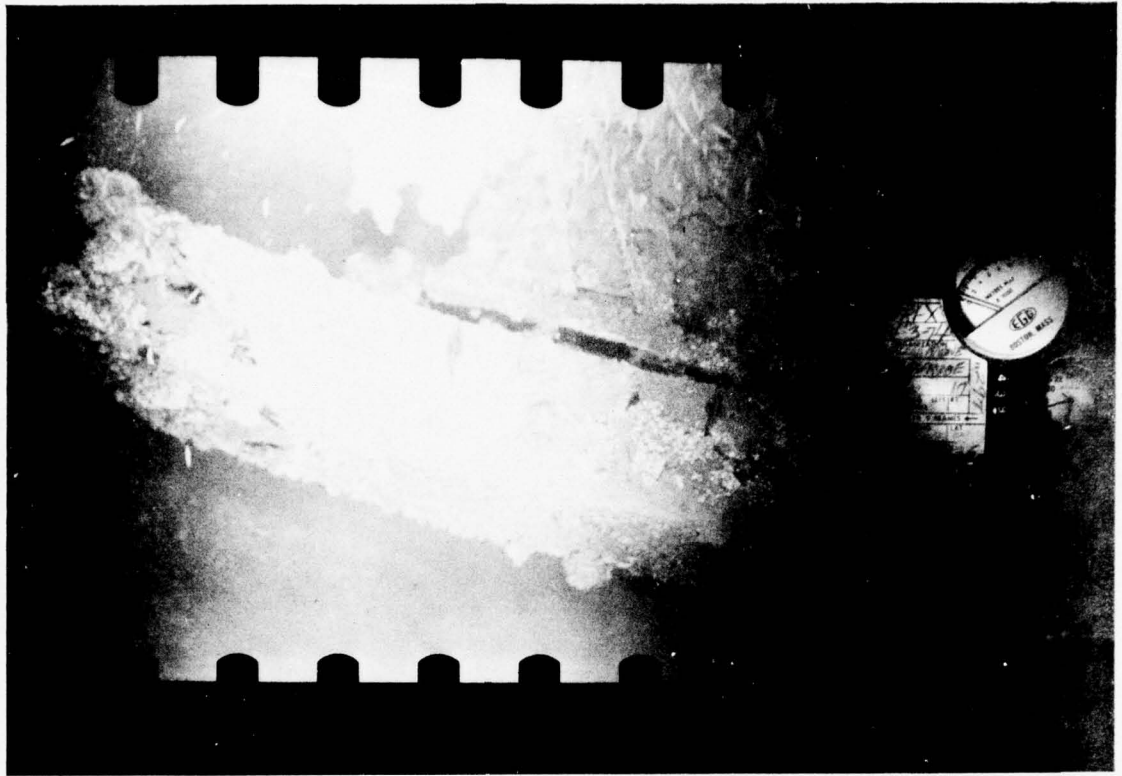
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EDITOR'S NOTE

With the results of the Seaprobe expedition the photographic proof that the long lost Monitor had finally been found created a situation of concern for those who had been responsible for unraveling the mystery. What would prevent the great value of the site from being destroyed by amateur souvenir hunters and disjointed recovery attempts? Quick steps were needed to protect Monitor from the ravishes of man.

One of the first to speak out on this issue was the Department of Cultural Resources, State of North Carolina.

Later at a meeting held 13 May 1974 to discuss the protection of the site at the Commerce Department, Commander Jones added his all too accurate prediction that within six months "we will find people going out with crude dredging equipment, attempting to dredge up or hook pieces of the wreck and pull them up." There was an incident the following May pointing out the important need for protection.

POLICY STATEMENT ON U.S.S. MONITOR

Department of Cultural Resources  
Division of Archives and History  
Archaeology Section

The U.S.S. Monitor was the first of a class of ironclad warships which significantly altered the shipbuilding art of the 19th century. Conceived by John Ericsson as a response to the formidable C.S.S. Virginia and constructed within one hundred days, the Monitor contained over 40 innovations which were to revolutionize naval warfare. Launched in January 1862 and commissioned by the navy the following month, the Monitor proceeded under tow by the tug Seith Low for its historic confrontation with the Virginia in Hampton Roads. Its low profile and turret being mistaken by Confederate forces for a "water tug," the Monitor arrived safely in Hampton Roads on March 8, 1862. The following day, the historic battle between the two warships occurred. The Virginia had as its target the grounded U.S.S. Minnesota. Having positioned itself between the stricken Minnesota and the approaching Virginia, the Monitor fired the first rounds from its XI-inch Dahlgrens. Surprised, and initially responding with grape and cannister, the Virginia was quick to recognize a powerful and elusive opponent. At the close of a six-hour battle, neither vessel had destroyed the other. The Virginia, however, retired. Following the battle, the Monitor remained at Hampton Roads for two months and then

returned to Washington for repairs and improvements. In November 1862, she again proceeded south. She left Hampton Roads on December 29th for Beaufort, North Carolina. In rough seas and under tow of the side-wheeler U.S.S. Rhode Island, the Monitor sank off Cape Hatteras, December 31, 1862, with a loss of sixteen men.

In August 1973 an oceanographic expedition aboard the R/V Eastward located and identified the wreck of the U.S.S. Monitor off the coast of North Carolina. The expedition, headed by Mr. John Newton, Duke University Marine Laboratory, represented the culmination of Monitor search efforts by numerous groups. Location and identification of the Monitor site was made possible by the collaborative efforts of specialists from Duke University, North Carolina State Department of Cultural Resources, Massachusetts Institute of Technology, National Geographic Society, the University of Delaware, and the U. S. Army Reserve. Vital facts concerning the U.S.S. Monitor's design, construction and history were gathered from records of the National Archives, the Mariners Museum, archives of the state of North Carolina, the Naval Academy, and other sources. From these, the track of the Monitor under tow of the U.S.S. Rhode Island during those last two days of December, 1862, was reconstructed. A rectangle representing the probable area of sinking was plotted on a current C&GS map and became the primary R/V Eastward

search area. Using side and vertical scan sonar, a magnetometer, precision navigation systems, and underwater cameras and television, the Eastward located and investigated the Monitor site. Samples dredged from a scar area near the wreck included clinkers and bituminous coal.

In March 1974, a second expedition to the Monitor site aboard the Alcoa Seaprobe was organized by John Newton, Duke University Marine Laboratory. The research team again included archaeologists from the Department of Cultural Resources, as well as historians and specialists from the National Geographic Society, the Naval Research Laboratory, and Massachusetts Institute of Technology. The expedition yielded extensive and potentially useful photographic and video-tape coverage of the wreck. A photomosaic of the wreck is being constructed from the photographs. Coal and wood specimens recovered by dredge from a bottom scar near the wreck are currently under study.

The Eastward and Seaprobe expeditions confirm the Monitor as an archaeological site of great historical and scientific importance. To consider it as other than archaeological would jeopardize all but the emotional values of the site. Most previous research concerning the Monitor has been frustrated by the lack of sufficient and consistent data relative to the subject. Although general descriptions of the vessel's construction have been available, the locations and details of the ship's fittings, machinery, and configuration were

unrecorded and hence are unknown. Only archaeological investigation of the site on the bottom is likely to provide answers to these questions. The essence of the archaeological technique is the study of context and association. Once the parts of a site are removed from their context their value as data are severely diminished. In the case of the Monitor, any attempt at salvage would almost surely break up or so scramble the wreck that the associations between the parts would be destroyed making it impossible to answer these questions. Thus, definitive answers to a host of architectural, technological, and historical questions regarding the Monitor can be unraveled only through thorough and systematic investigation of the wreck on the seafloor.

The kinds of questions which can be answered archaeologically include but are not limited to: type and location of condensers; engines utilized to rotate the turret; nature of the fresh water system; method used to absorb the forward thrust of the propeller shaft; type of bearing and stuffing box used on the propeller shaft; vessel heating and ventilation system; metal alloys used in construction of the ship's engines and machinery; details of the vessel's steering system; mechanics of the winch used to raise the anchor; and method of joining wood to metal.

The identification of the Monitor brings to a close more than a century of search efforts. At the same time it initiates new sets of problems. The most significant of these

is the site's potential destruction through looting and/or attempted salvage. The Archaeology Section, an instrumental force in the discovery and identification of the Monitor, has a strong commitment toward the protection and preservation of the Monitor site as a valuable and nonrenewable cultural resource. The section maintains that, in light of the extreme value of the site and the limits of present archaeological technology, costs in terms of shiptime and instrumentation, and the dangers to human life, attempts to raise the vessel either wholly or in part are unwarranted. First, shiptime and instrumentation costs are extremely high—the combined costs of Eastward and Seaprobe three-week seetime exceeded \$200,000. The months of shipboard time required to place and support a team of archaeologically-trained divers on the Monitor site would be very expensive. Second, as ascertained by videotapes and photographs, the wreck is in extremely poor condition. Preservation of the wreck would be costly, if indeed preservation could be accomplished at all. Third, the wreck lies at a depth of over 200 feet in treacherous Cape Hatteras waters. Visibility ranges from five to fifteen feet; bottom currents exceed three knots. To work on the wreck would require a mixed gas environment. There are few qualified archaeologists willing to risk their lives or those of others under these conditions.

Given these parameters, the Archaeology Section recognizes the need for limited scientific investigation of the

Monitor as well as preservation of the site. To these ends, the Archaeology Section is suggesting nomination of the Monitor site to the National Register of Historic Places. In addition, the section will cooperate fully with those federal agencies seeking to provide further protection and preservation of the site. Finally, the section maintains the following position with regard to any Monitor expeditions by any party:

1. Any investigation of the Monitor site must be coordinated by a professional archaeologist. The research team, headed by an archaeologist as chief scientist, must include archaeologists as well as specialists skilled in techniques of site reconnaissance, exploration, recovery, and preservation of artifacts and other physical and/or visible features.

2. Any investigation of the Monitor site must be preceded by a well conceived research design based on a complete map of the site, as well as all available historical information. The research design must be jointly developed well in advance on any anticipated expedition.

Comments for Department of Commerce Meeting on 13 May

Good Morning Gentlemen:

I have been invited to give you a brief outline of what we found on our recent expedition with the SeaProbe regarding the Monitor. I would like to preface my comments concerning what we found by telling you that I am not an expert on the Monitor. However I have every reason to believe that the wreck we found is in fact that of the Monitor and this opinion is concurred in by all of the experts with whom I have had an opportunity to discuss the matter. At any rate I would like to show you a few slides which I hope will give you some idea of the condition of the wreck and then I would like to discuss with you the general location of the wreck and the conditions of the ocean in that area.

SLIDES

Gentlemen, you have just seen first hand the condition of the wreck. This wreck lies in a little over 200 feet of water in an area approximately 15 miles south of Cape Hatteras. This is in an area of the ocean well-known for bad weather, rough seas and treacherous currents. It has not earned the reputation of being the "Graveyard of the Atlantic" without just cause.

It's important that we recognize, all of us, that although this wreck lies in such a dangerous area there will be considerable

interest on the part of numerous amateurs to go down and attempt to bring up pieces of it. From a standpoint of the archeology and history involved I would like to defer to the opinion of the experts, and address my remarks primarily in the area of safety and the protection of the public. It is important that we recognize this wreck is in water beyond the safe diving limits of amateurs, scuba divers, etc. This does not mean that it's beyond the limits that many of these people may try to go to. We, in the Navy consider 130 feet as the maximum safe depth for scuba diving and consider scuba diving totally unsuited for this sort of a wreck. However, I feel fairly confident that within a relatively short period of time we will have amateurs attempting to locate this site and dive on it using ordinary scuba equipment. Someone in all likelihood will get hurt.

In addition to the problems related to the safety of diving, I think it is also quite likely that we will find people going out with crude dredging equipment, attempting to dredge up or hook pieces of the wreck and pull them up. I suspect that this would not create any personnel hazards but it certainly could easily lead to a great deal of damage to the wreck site. I therefore hope that one of the things that will come out of this meeting ultimately will be the necessary decisions to create some sort of a sanctuary at the site of the Monitor so that we may preserve for history,

for the engineers and archeologists who are interested in studying this wreck, as much information as nature has permitted to be preserved for the last 111 years.

I'm not sure if we make the Monitor a marine sanctuary or in some other way make it illegal for people to go out and dive on it that we can necessarily keep people from doing it, but it would be a discouragement to most charter boat operators and other people, and let's face it, the wreck is not going to be easy for most of these people to find.

EDITOR'S NOTE

Steps were taken by the State of North Carolina to nominate the Monitor as a research area under the Marine Sanctuary Act of 1972. Thus the gears were in motion to make the Monitor site the first Marine Sanctuary in the United States.

This action would effectively control access to the site, setting the stage for a well-planned and well-executed project of the future, hopefully bringing to light much of what has been lost for 112 years.

The following inserts are the guidelines for the managing of the sanctuary and the environmental impact statement by N.O.A.A.

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FEDERAL REGISTER

Vol. 39, No. 125

Thursday, June 27, 1974

Title 15—Commerce and Foreign Trade

Chapter IX—National Oceanic and Atmospheric Administration,  
Department of Commerce

Part 922—Marine Sanctuaries

The National Oceanic and Atmospheric Administration (NOAA) on March 19, 1974 (39FR 10255), proposed guidelines pursuant to Title III of the Marine Protection Research and Sanctuaries Act of 1972 (P.L. 92-532, 86 Stat. 1061) and the delegation of authority by the Secretary of Commerce dated March 13, 1974 authorizing the Administrator of NOAA to exercise the authority granted under the Title, for the purpose of setting forth the procedure by which areas may be nominated as marine sanctuaries and the concepts, policies, and procedures for the processing of nominations and the selection, designation and operation of a marine sanctuary.

Written comments were to be submitted to the Office of Coastal Environment, National Oceanic and Atmospheric Administration before May 1, 1974, and consideration has been given these comments.

The Title recognizes that certain areas of the ocean waters, as far seaward as the outer edge of the Continental Shelf, or other coastal waters where the tide ebbs and flows, or of the Great Lakes and their connecting waters, need to be preserved or restored for their conservation, recreational ecological or esthetic values.

The Secretary of Commerce (Administrator NOAA) after consultation with the Secretaries of State, Defense, the Interior, Transportation, the Administrator of the Environmental Protection Agency, other interested Federal Agencies, the State('s) involved and with the approval of the President, may designate a marine sanctuary.

Prior to designating a marine sanctuary which includes waters lying within the territorial limits of any state, the Secretary (Administrator NOAA), shall consult with and give due consideration to the view of the responsible state officials involved. A designation under this section shall become effective sixty days after it is published, unless the governor of any state involved shall, before the expiration of the sixty-day period, certify to the Secretary that the designation, or a specified portion thereof, is unacceptable to his state, in which case the designated sanctuary shall not include the area certified as unacceptable until such time as the governor withdraws his certification of unacceptability.

In addition, recognizing the key role of state(s) in areas adjacent to but outside their jurisdiction, the Secretary (Administrator NOAA) will consult with the state(s) and give due consideration to the views of the responsible state officials involved.

Where areas outside the territorial sea are involved, the State Department is to negotiate with other Governments to

achieve protection of a sanctuary to the maximum extent possible.

The Title recognizes that a program will be undertaken by NOAA to identify areas for marine sanctuary status, and that nominations will be made by states, local governments, organizations, industry and individuals. Public participation will be encouraged during the study and analysis phases leading to designation. Prior to a designation of a marine sanctuary, public hearings must be held in the coastal areas most affected by the designation. Regulations are to be promulgated for each such designated sanctuary.

These guidelines set forth the concepts and procedures under which marine sanctuaries will be designated and managed.

The National Oceanic and Atmospheric Administration is publishing herewith the final guidelines describing procedures for nomination, processing of the nomination, designation, revisions, and certification of activities within marine sanctuaries. The final guidelines herewith were revised from the proposed guidelines based on comments received. A total of twenty-two (22) states, agencies, organizations and individuals submitted responses to the proposed Title III Guidelines published in the FEDERAL REGISTER on March 19, 1974. Of these responses received, four (4) were wholly favorable as to the nature and content of the guidelines as they appear in the FEDERAL REGISTER on March 19, 1974. Eighteen (18) commentators submitted suggestions concerning the proposed title guidelines.

The following analysis summarizes key comments received on various sections of the proposed rules and presents a rationale for the changes made:

1. Introduction. Concern was expressed that overly large areas of the coastal waters would be made marine sanctuaries. It is not expected, however, that large areas of the oceans and coastal waters will be designated as marine sanctuaries, and all activity prohibited or drastically reduced. It is expected that sanctuaries will be only large enough to permit accomplishment of the purposes specified in the Act.

In each area designated, some activities will be totally compatible, others will need to be modified, and others will not be permitted. The size of the area will depend upon the proposal, an analysis of the factual information, the outcome of the draft environmental impact statement process, and public hearings.

Another commentator indicated that the guidelines failed to properly implement the policy underlying the Title. With this single exception, the consensus of the reviewers was that the proposed guidelines were basically in harmony with the legislative intent and authority.

One commentator stated that multiple use of various sanctuaries seem to provide for extensive use that is neither intended nor permitted by the statute. An opposite point of view was expressed by commentators that the guidelines implied

too restrictive a view of multiple use.

The question of multiple use will need to be examined on a case by case basis. The legislative history of the Title clearly indicates that multiple use of each area should be maximized consistent with the primary purpose. Additionally, the statute clearly indicates, as a safeguard that "no permit, license, or other authorization issued pursuant to any other authority shall be valid unless the Secretary (Administrator) shall certify that the permitted activity is consistent with the purposes of this title and can be carried out within the regulations promulgated. . . ."

2. Progammatic objectives. One reviewer indicated that progammatic objectives 922.2(a) provided for protection of geological and oceanographic features whereas the classification 922.10 did not. The classification 922.10 has been modified to provide for these purposes. It was suggested that estuarine sanctuaries be added to the list of public areas in 922.2(b). The phrase "other preserved areas" covers not only estuarine sanctuaries but also other areas held for the public benefit. The intent is to complement public and private lands that are held and managed for purposes analogous to Title III.

3. Definitions. Concern was expressed that the definition of multiple use did not clearly express the concept that a sanctuary will have a primary purpose to which other uses must be compatible. The definitions has been modified accordingly.

4. Effect of Marine Sanctuary Designation for Waters Outside of U.S. Jurisdictional Limits. It was indicated that 922.12 did not accurately reflect the 1958 Geneva Convention on the High Seas. The Department of State made specific recommendations in lieu of the proposed section. Their recommendation has been incorporated verbatim.

5. Nominations. Several commentators asserted that the nomination process was not clearly elaborated and that no indication exists that NOAA is charged with the responsibility to take an active role in seeking areas for designation as marine sanctuaries.

Changes have been made to explain how interested individuals and organizations and their status and to explain how NOAA will stimulate and coordinate a Federal program.

6. Analysis of nominations. Concern was indicated that the public was not included in the analysis process at an early enough time and that the guidelines were ambiguous as to the preparation of a draft environmental impact statement and public notice thereof.

Changes have been made to indicate that a draft environmental impact statement will be prepared and that public notice will announce its public availability and solicit comment.

7. Consultation. One commentator indicated the guidelines did not elaborate how differences between a state and NOAA would be resolved. Where the proposed sanctuary is

within areas over which the state has jurisdiction the Governor has veto power over the action. It is anticipated that in all considerations the state(s) affected will be fully involved in the process, thus differences can be resolved at each step of the process.

8. Revision and certification. Concern was expressed that provisions were omitted for revising an established sanctuary and for certification of proposed activities in a sanctuary.

New sections have been added in order to satisfy these concerns.

T. P. GLEITER,  
Assistant Administrator  
for Administration.

A new Part 922 is added, to read as follows:

Subpart A—General

Sec.

922.1 Policy and objectives.

922.2 Programmatic objectives.

Subpart B—Classifications of Marine Sanctuaries

922.10 Classifications.

922.11 Definitions.

922.12 Effect of marine sanctuary designation of waters outside of U. S. jurisdiction limits.

922.13 Effect of international principles involving freedom of the seas.

Subpart C—Nomination of Candidates

- 922.20 Nominations.
- 922.21 Analysis of nomination.
- 922.22 Public participation.
- 922.23 Consultation process.
- 922.24 Designation.
- 922.25 Operation.
- 922.26 Revision.
- 922.27 Certification of other activities.

Subpart D—Enforcement

- 922.30 Civil penalties.
- 922.31 Notice of violation.
- 922.32 Enforcement hearings.
- 922.33 Determinations.
- 922.34 Final action.

AUTHORITY: Title III, Pub. L. 92-532, 86 Stat. 1061, and delegation of authority by Secretary of Commerce, March 13, 1974.

Subpart A—General

- 922.1 Policy and objectives.

(a) The Marine Sanctuaries Program shall be conducted under the expressed policy of the Title which is to designate areas as far seaward as the outer edge of the continental shelf, as defined in the Convention of the Continental Shelf, 15 U.S.T. 74; TIAS 5578, of other coastal waters where the tide ebbs and flows, or of the Great Lakes and their connecting

waters, which the Administrator determines necessary for the purpose of preserving or restoring such areas for their conservation, recreational, ecological, or esthetic values.

(b) Multiple use of marine sanctuaries as defined in this subpart will be permitted to the extent the uses are compatible with the primary purpose(s) of the sanctuary.

(c) It is anticipated that the marine sanctuaries program will be conducted in close cooperation with section 312 of the Coastal Zone Management Act of 1972, P.L. 92-583, which recognizes that the coastal zone is rich in a variety of natural, commercial, recreational, industrial and esthetic resources of immediate and potential value to the present and future well-being of the nation and which authorizes the Secretary of Commerce to make available to a coastal State grants of up to 50 percent of the costs of acquisition, development and operation of estuarine sanctuaries.

#### 922.2 Programmatic objectives.

Marine Sanctuaries may be designated to preserve, restore, or enhance areas for their conservational, recreational, ecological, research or esthetic values in coastal waters. Anticipated examples include:

(a) Areas necessary to protect valuable, unique or endangered marine life, geological features, and oceanographic features.

(b) Areas to complement and enhance public areas such as

parks, national seashores and national or state monuments and other preserved areas.

(c) Areas important to the survival and preservation of the nation's fisheries and other ocean resources.

(d) Areas to advance and promote research which will lead to a more thorough understanding of the marine ecosystem and the impact of man's activities.

#### Subpart B—Classification of Marine Sanctuaries

##### 922.10 Classifications.

Multiple use may be permitted in each classification to the extent the uses are compatible with the primary purpose(s) for which the sanctuary is established. Areas may be established to augment public and private lands or marine areas set aside by local, state or Federal government and private organizations for analogous purposes. Marine sanctuaries will be established for one, or a combination of, the following purposes:

(a) Habitat areas. Areas established under this concept are for the preservation, protection and management of essential or specialized habitats representative of important marine systems. Management emphasis will be toward preservation. The quantity and type of public use will be limited and controlled to protect the values for which the area was created.

(b) Species areas. Areas established under this concept are for conservation of genetic resources. Management emphasis may be to maintain species, populations and communities

for restocking other areas and for reestablishment purposes in the future. The result will be a contribution to the goal stated by the Council on Environmental Quality, that is, "the widest possible diversity of and within species should be maintained for ecological stability of the biosphere and for use as natural resources." The orientation envisaged will be toward species preservation by protection of such areas as migratory pathways, spawning grounds, nursery grounds, and the constraints on these areas will be those necessary to achieve these purposes.

(c) Research areas. (1) Areas established under this concept will exist for scientific research and education in support of management programs carried out for the purpose of the title.

(2) The purpose of the research areas is to establish ecological baselines against which to compare and predict the effect on man's activities, and to develop an understanding of natural processes. Research areas will be chosen according to the biota they support, to include representative samples of the significant ecosystems in the nation, and to the history of prior research carried out in the area, and its proximity or availability to potential uses marine sanctuary designation will insure that the area will be relatively unaffected for a long period of time, thus adding a measure of stability to a research program and the value of the data in management decisions.

(d) Recreational and esthetic areas. Areas established under this concept will be based on esthetic or recreational value.

(e) Unique areas. Areas established under this concept will be to protect unique or nearly one of a kind geological, oceanographic, or living resource feature.

922.11 Definitions.

As used in this part, the following terms shall have the meaning indicated below:

(a) "Administrator" means the Administrator of the National Oceanic and Atmospheric Administration.

(b) "Marine sanctuary" means those areas of the ocean waters, as far seaward as the outer edge of the Continental Shelf, as defined in the Convention of the Continental Shelf, 15 U.S.T. 74, TIAS 5578, of other coastal waters where the tide ebbs and flows, of the Great Lakes and their connecting waters, for the purpose of preserving, restoring or enhancing such areas for their conservation, recreational, ecological, research, or esthetic values.

(c) The term "multiple use" as used in this section shall mean the contemporaneous utilization of an area or resource for a variety of compatible purposes to the primary purpose so as to provide more than one benefit. The term implies the long-term, continued uses of such resources in such a fashion that one will not interfere with, diminish, or

prevent other permitted uses.

(d) "Ocean waters" means those waters of the open seas lying seaward of the baseline from which the territorial sea is measured, as provided for in the Convention of the Territorial Sea and the Contiguous Zone, 15 U.S.T. 1606, TIAS 5639.

(e) "Person" means any private individual, partnership, corporation, or other entity; or any officer, employee, agent, department, agency or instrumentality of the Federal government or any state or local unit of government.

(f) "Secretary" means the Secretary of Commerce.

922.12 Effect of marine sanctuary designation for waters, outside the U. S. jurisdictional limits.

The designation of a marine sanctuary and the regulations pertaining to it will be binding on United States nationals. The United States has exclusive jurisdiction over all resources within the territorial sea in which it exercises sovereignty subject only to the right of innocent passage. Beyond that limit, the U. S. regulations would be binding on foreign citizens only to the extent consistent with international law.

922.13 Effect on international principles involving freedom of the seas.

The designation of a marine sanctuary will not infringe upon the normal rights of innocent passage in territorial waters, the rights of navigation through international straits, or the freedoms of the high seas, including freedom of navigation.

Subpart C—Nomination of Candidates

922.20 Nominations.

(a) The nomination of a given marine area for consideration as a designated marine sanctuary may result from studies carried out by Federal, State or local officials or from any other interested persons. Nominations should be addressed to:

Director, Office of Coastal Zone Management  
National Oceanic and Atmospheric Administration  
U. S. Department of Commerce  
Rockville, Maryland 20852

Information may be obtained on nominations by inquiring to the above office.

(b) The nomination for designation as a marine sanctuary must contain the following information:

(1) A general description of the area including the following information:

- (i) Purpose for which the nomination is made;
- (ii) Geographic coordinates of the site;
- (iii) Plant and animal life in the area;
- (iv) Geological characteristics of the area; and
- (v) Present and prospective uses and impacts on the area and resources thereof.

(2) A nomination for research purpose should contain a specific scientific justification, a statement of how the research will aid in management decisions, and a history of prior research carried out on the area.

(c) A Federal program will be stimulated and coordinated by NOAA to establish a coherent system of estuarine and marine ecosystems, recreational and esthetic areas, and research areas. It is anticipated that this system will emerge as part of the State coastal zone management plans, taking into account the national interest.

922.21 Analysis of nomination.

(a) Upon receipt of a nomination or as the result of action by NOAA, the involved State(s), other Federal agencies, will be notified of the nomination and requested to participate in a preliminary review to determine feasibility.

(b) If a preliminary review demonstrates the feasibility of the nomination, a more in-depth study will be required. Factual information will be gathered to obtain an understanding of the:

- (1) Animal and plant life;
- (2) Geological features;
- (3) Weather and oceanographic conditions and features;
- (4) Present and potential recreational and economic uses;
- (5) Present and potential adjacent land uses;
- (6) Laws and programs of Federal, State and local government that apply to the area.

(c) An analysis will be made of how the sanctuary will impact on the present and potential uses, and how these uses will impact on the primary purpose for which the sanctuary is being considered.

(d) The factual information and the results of the analysis activity will be used in preparation of a draft environmental impact statement and proposed regulations. Subsequent to completion of the in-depth study by the Administrator, a draft Environmental Impact Statement will be prepared and circulated for review in compliance with the National Environmental Policy Act of 1969 and implementing the Council on Environmental Quality guidelines. The draft Environmental Impact Statement will discuss proposed regulations and operational procedures and programs.

922.22 Public participation.

(a) The purpose of this section is to ensure that all interested parties have the opportunity to present their views.

(b) When a nomination has been determined feasible, a press release will be issued by NOAA announcing the nomination and that a Draft Environmental Impact Statement is in preparation.

(c) When notice of the Draft Environmental Impact Statement (DEIS) has been published by the Council on Environmental Quality, a press release will be issued by NOAA announcing the DEIS and soliciting comment.

(d) The Administrator will hold public hearings in the coastal areas which would be most directly affected by such designation, for the purpose of receiving and giving proper

consideration to the views of any interested party. Such hearings should be held no earlier than 30 days after the Council on Environmental Quality announces receipt of the draft Environmental Impact Statement by publication in the FEDERAL REGISTER. Public hearings need not be held on each proposal or nomination, but only when sufficient facts and data are available to the Administrator which indicates that designation action appears to be feasible, and a Draft Environmental Impact Statement has been prepared.

922.23 Consultation process.

The consultation process is designed to coordinate the interests of the State and various Federal departments and agencies, including those responsible for the management of fisheries resources, the protection of national security and transportation interests and the recognition of responsibility for the exploration and exploitation of mineral resources.

922.24 Designation.

The designation by the Administrator will clearly state the purpose for which the sanctuary is designated, regulations and guidelines promulgated, and management program under which it will operate.

922.25 Operation.

The designation of a marine sanctuary establishes the basis for a continuous operating program designated to maintain the purpose for which the sanctuary is designated. This

involves a program of continuous scientific evaluation, surveillance, and enforcement to insure the integrity of the system. An interpretive program may be conducted to aid in public understanding and enjoyment of the sanctuary. A specific program will be established for each designated marine sanctuary.

922.26 Revision.

Revision of a designated marine sanctuary may be proposed by the same procedure as for nomination. A public hearing will be held in the area most affected by the proposed action. A Draft Environmental Impact Statement may be required if the proposed action will significantly affect the quality of the Environment.

922.27 Certification of other activities.

The Act specifies that once a marine sanctuary is designated, no permit, license, or other authorization issued pursuant to any other authority shall be valid unless the Secretary shall certify that the permitted activity is consistent with the purposes of this title and can be carried out within the regulations promulgated. The Regulations promulgated for each sanctuary will contain a certification procedure.

Subpart D—Enforcement

922.30 Penalties.

Any person subject to the jurisdiction of the United States who violates any regulation issued pursuant to this

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title will be liable to a civil penalty of not more than \$50,000 for each such violation, to be assessed by the Administrator. Each day of a continuing violation will constitute a separate violation. No penalty will be assessed under this section until the person charged has been given notice and an opportunity to be heard. Upon failure of the offending party to pay an assessed penalty, the Attorney General, at the request of the Administrator, will commence action in the appropriate district court of the United States in order to collect the penalty and to seek such other relief as may be appropriate. A vessel used in the violation of a regulation issued pursuant to this title will be liable in rem for any civil penalty assessed for such violation and may be proceeded against in any district court of the United States having jurisdiction thereof. The district courts of the United States will have jurisdiction to restrain a violation of the regulations issued pursuant to this title and to grant such other relief as may be appropriate. Actions will be brought by the Attorney General in the name of the United States, either on his own initiative or at the request of the Administrator.

922.31 Notice of violation.

Upon receipt of information that any person has violated any provision of this title, the Administrator or his designee will notify such person in writing of the violation with

which he is charged, and will convene a hearing to be conducted no sooner than 60 days after such notice, at a convenient location, before a hearing officer. Such hearing will be conducted in accordance with the procedures of 922.32.

922.32 Enforcement hearings.

Hearings convened pursuant to 922.31 will be hearings on a record before a hearing officer. Parties may be represented by counsel, and will have the right to submit motions, to present evidence in their own behalf, to cross examine adverse witnesses, to be apprised of all evidence considered by the hearing officer, and to receive copies of the transcript of the proceedings. Formal rules of evidence will not apply. The hearing officer will rule on all evidentiary matters, and on all motions, which will be subject to review pursuant to 922.33.

922.33 Determinations.

Within 30 days following conclusion of the hearing, the hearing officer will in all cases make findings of facts and recommendations to the Administrator, including, when appropriate, a recommended appropriate penalty, after consideration of the gravity of the violation, prior violations by the person charged, and the demonstrated good faith by such person in attempting to achieve rapid compliance with the provisions of the title and regulations issued pursuant thereto. A copy of the findings and recommendations of the hearing officer

shall be provided to the person charged at the same time they are forwarded to the Administrator. Within 30 days of the date on which the hearing officer's findings and recommendations are forwarded to the Administrator, any party objecting thereto may file written exceptions with the Administrator.

922.34 Final action.

A final order on a proceeding under this part will be issued by the Administrator or by such other person designated by the Administrator to take such final action, no sooner than 30 days following receipt of the findings and recommendations of the hearing officer. A copy of the final order will be served by registered mail (return receipt requested) on the person charged or his representative. In the event the final order assesses a penalty, it shall be payable within 60 days of the date of receipt of the final order, unless judicial review of the order is sought by the person against whom the penalty is assessed.

## SUMMARY

### Draft Environmental Impact Statement

#### Designation of USS Monitor Site as Research Marine Sanctuary

Responsible Office: NOAA's Office of Coastal Zone Management,  
Maryland

1. Name of Action (X) Administrative
2. Description of Action
3. a. Environmental Impacts

No impact will occur to the environment. Some controls are placed on activities at the wreck site.

4. Alternatives

The alternatives considered were: (1) not to establish a sanctuary. This was rejected because uncontrolled salvage and artifact collecting could occur that would result in damage to the USS Monitor. Such damage would lessen or destroy the value of the vessel for archaeological and historic research and the cultural value to the American people. (2) to establish a sanctuary with no access to the wreckage. This alternative was rejected since public appreciation and enjoyment of an underwater features depends upon some form of visual observation. (3) to establish the USS Monitor site as another classification of a sanctuary, for instance, Unique; a unique area would tend to be managed in a "hands off fashion"; whereas that activity necessary for study of the resources which is subject to a research sanctuary designation would be

permitted. Although the unique alternative is feasible the primary value of the sanctuary will be for archaeological and observational research.

#### 1.0 Project Description

It is proposed to establish a Research Area under the authority of Title III of the Marine Protection Research and Sanctuaries Act of 1972. The purpose of the research area is to preserve the wreckage of the USS Monitor for historic and cultural values and archaeological research.

On August 27, 1973, an interdisciplinary scientific party from the North Carolina Department of Cultural Resources, Duke University, Massachusetts Institute of Technology, and the University of Delaware located the remains of the Civil War ironclad USS Monitor. The wreck lies in 220' of water on a hard and shell bottom 16.10 miles south-southeast of the present Cape Hatteras, North Carolina Light (Fl 15 sec 191 ft 20M-C&GS 1109 2/20/71) on a bearing of 160 true. From the Diamond Shoals Tower (Fl 2½ sec 20 ft 17M-C&GS 1109 2/20/71) the site lies 10.50 miles south-southwest on a geographical range bearing 211 true. The geographic coordinates for the location are 35°00' 23" North Latitude, 75°24' 32" West Longitude.

Analysis of the data collected during the two visits to the site revealed that the vessel rests upside down. Sand accumulation has obscured portions of the starboard side to a

height of approximately six feet, however, the port side remains exposed. The displaced turret partially obscured by the hull protrudes from the port quarter. In the stern a considerable portion of the starboard quarter has separated from the upper hull and now lies on the bottom directly under its original position. The upper hull exists in a reasonable state of preservation and remains virtually intact. The turret, because of its heavy construction, exists in a similar state of preservation.

Portions of exposed lower hull, has suffered considerable damage. Forward of the vessel's only substantial athwartship bulkhead, deterioration of the lower hull seems to be quite extensive. With the exception of portions of the starboard side, this portion of the hull disintegrated to the level of the bottom of the armor belt. Such extensive damage may have occurred during World War II as the result of depth charges. Aft of the bulkhead, damage more closely resembles what could be considered natural deterioration. Here most of the lower hull plating remains intact and there is little of the heavy structural damage apparent in the forward areas.

Despite the damage there are excellent possibilities for additional research at the site, because the location has, until recently remained unknown the integrity of the site has not been disturbed by relic hunting or salvage operations. Although deteriorated to some extent, nearly all of the vessel's

parts are available at the site in place. It is important to naval architects and historians to ascertain design features that are unknown owing to lost records.

The Monitor is perhaps best known for its celebrated encounter with the Confederate ironclad the CSS Virginia, yet this unique vessel represents one of the most revolutionary concepts in 19th century naval technology. Her construction, by Swedish engineer John Ericsson, marks one of the most radical departures from established shipbuilding tradition in the history of marine architecture. The Monitor has been widely accepted as the symbol of the beginning of the end for the wooden sail-powered Ship-of-the-line. As the first comprehensive naval response to the technological advances of the scientific and industrial revolution, the Monitor, represents the first major step in the development of the modern capital ship.

Thus, from an historic and technological standpoint, the wreck represents one of the more valuable mid-nineteenth century marine archaeological sites available for scientific investigation. Because the vessel played a pivotal role in the transition from sail to steam and from wood to iron, the remains contain an invaluable source of information unavailable elsewhere. As a significant portion of our national heritage and a valuable and nonrenewable cultural resource, the wreck merits protection from looting and salvage attempts which would

almost surely destroy the information preserved at the site.

Because the Monitor lies outside the territorial waters of the state of North Carolina, adequate legislative protection cannot come from within the state. However, since the site lies on the Continental Shelf, it may be protected under the authority of Title III of the Marine Protection Research and Sanctuaries Act of 1972 (Pub. L. 92532; 86 Stat. 1061) which specifically authorizes the Secretary of Commerce to designate Marine Sanctuaries to the outer edge of the continental shelf. To preserve the wreck site the State of North Carolina has nominated the area as a Research area pursuant to Subpart B 922.10-c of the Marine Sanctuary guidelines promulgated in the June 27, 1974 Federal Register. Access to the site would be controlled by a NOAA issued permit.

The proposed geographical extent of the area of the ocean with a diameter of not less than one mile, centering on a point located at 35°00'23" North Latitude and 75°24' 32" West Longitude. This would insure that any remains which have been dispersed by the strong currents in the area will be included.

## 2.0 Proposed Regulations

Section 302 (f) of the Marine Sanctuaries title provides for the issuance of necessary and reasonable regulations to control any activities within the designated marine sanctuary. The following are those proposed regulations with the objective to maintain the structural integrity of the vessel.

1. Anchorage is prohibited in the sanctuary, unless (a) it occurs as the result of an attempt to maintain vessel safety during a natural disaster such as a hurricane or (b) when a research permit has been issued.

2. A permit must be obtained to conduct research.

3. All salvage operations are prohibited.

4. No portion of the vessel may be removed from its existing location unless a research permit has been issued to do so.

5. Diving is prohibited unless it is done as part of a scientific program for which a permit has been obtained.

6. Dredging, grappling or use of explosives are prohibited within the sanctuary.

7. Trawling is prohibited.

8. All equipment utilized in study of the Monitor research must be used so as not to damage the vessel. Any malfunction or error in conduct of research must be reported to NOAA immediately. Permits may be issued by NOAA.

Research proposals should be addressed to the Administrator of NOAA or his designated representative. Each proposal will be subject to review by interested Federal Agencies - the State of North Carolina and various scientific experts. The focus of the review will be to ascertain whether or not damage will be done to the vessel. Study methods and equipment to be employed must be, in the judgment of the scientific reviewers

and NOAA, sufficiently developed and tested to reliably carry out the research program without a high probability of accidental damage. In essence, efforts to advance the "states of the Art" will not be acceptable. This can be done on other wrecks with little or no historic and aesthetic values to the American people.

The relationship of the proposed action to land use plans, policies and controls for the affected area.

This action conforms to the well-established policy of Congress, "It is declared that it is a national policy to preserve for public use historic sites, buildings, and objects of national significance for the inspiration and benefit of the people of the United States," August 21, 1935, c 593, S 1, 49 Stat. 666. The USS Monitor has also been nominated to the registry of National Historic Places by the Bureau of Land Management.

The probable impact of the proposed action on the environment

The site does serve as an artificial reef and supports the usual colony of nonmigratory marine life and fouling organisms. However, no comprehensive information is available at present on the number and types of marine life and plants.

Preserving the vessel intact will not have an impact on sedimentary processes, currents, and water mass movements.

Alternatives to the proposed action

No sanctuary: This option would expose the vessel to

treasure hunting activities. The result could be destruction of the structural integrity of the vessel and loss of cultural, historical and archaeological values. This option has been rejected.

Sanctuary with no research or other activity permitted: The result of this option would be that the American people would be denied visual enjoyment and understanding of the vessel. Since visual equipment necessary for interpretative programs would be precluded, the only benefit would be knowing an historic site is protected. We consider that is not sufficient justification for sanctuary status.

Designation as another type of sanctuary: Although the wreck site could qualify as a unique sanctuary the primary purpose for the sanctuary is archaeological research. In general, a unique sanctuary will be managed to eliminate or minimize man's interaction with the resource or feature; whereas in a research sanctuary the purpose is to conduct well designed and executed studies to understand and describe the resource in question. Therefore, we believe that best alternative is the Research Classification.

Probable adverse environmental effects

The proposed regulation will have certain adverse effect: Research projects will be subject to the additional review necessary for a permit. Certain types of research such as geophysical would be restricted to non-explosive techniques.

Fisheries activities will be limited to non-trawling types. Salvagers will be precluded from extracting portions or the entire vessel for profit.

We are unaware of any significant economic or recreational use of the area. The exception being salvage of the vessel. Also the hostile nature of the marine environment at the proposed sanctuary site, attested to by the many shipwrecks in the area, severely limits potential economic and recreational uses. Moreover, since there will be no interference whatsoever with the right of free and innocent passage, we expect the magnitude of the adverse impacts to be minimal.

The relationship between local short-term uses of man's environment and the maintenance of long-term productivity

No irretrievable commitments of resources is involved. This DEIS analysis in addition to congressional policy on the value of historic places leads us to conclusion that the minimal environmental impacts that occur are more than offset by the public benefits. Therefore, the USS Monitor site should be designated as a Research Marine Sanctuary and that the proposed regulation go forward to public hearing as the next step in the processing of the nomination.

CONCLUSION

The Monitor has been found. It will become the first marine sanctuary in the United States on 30 January 1975. The efforts of many over a period of 25 years has made all of this possible. But what of the future? Almost daily what remains of the Monitor is deteriorating in its salt water environment, but removing the hulk or pieces of it also means their destruction as a new technology for the preservation of old iron has to be developed and made economically feasible before anyone dare touch it. Perhaps an extended broad based research program will be developed to intricately study many of the details which were only briefly surveyed in this project. Certainly, the discovery of the Monitor is the major marine archeological find of this decade in regards to United States Naval History, one worthy of study and preservation. A great sustaining force throughout the search and hopefully in the future has been the terrific history of the little ship. Nowhere else in our history has a ship of such a short career been as well celebrated as the Monitor. The story behind the Monitor and her role at a crucial juncture of our history will continue to inspire and intrigue all who are familiar with it.

There is only one original USS Monitor and there will never be another. Perhaps someday, the Monitor will once again stand porter at the entrance of the Chesapeake.

FINAL EDITOR'S NOTE

Before laying down my pen and closing the cover on Project Cheesebox, a final note of thanks is needed. Few students on the undergraduate level are afforded the opportunity to work on such a project with such a high caliber of people. Nowhere has the challenge been greater and more exciting than working on this project. Speaking for the other Midshipmen and myself, we will always remember the assistance and advice so readily given by individuals in the Naval community, the National Geographic Society, and of special note the U. S. Naval Academy. For some this project was the highlight of four long years at the Academy and will long be remembered as we continue to serve in the U.S. Navy. We will always look back with pride at the dreams that became reality while attending the U.S. Naval Academy.

PRECEDING PAGE, BLANK, NOT FILMED

ADDENDUM I

On 30 January 1975, at a ceremony held in the lobby of the Department of Commerce Building, Washington, D. C., the Monitor site was designated a Marine Sanctuary.

PROGRAM

SELECTIONS

U. S. Navy Ceremonial Band

WELCOME

Dr. Robert M. White  
Administrator  
National Oceanic and Atmospheric Administration

FINDING THE MONITOR

Mr. John Newton  
Marine Superintendent  
Oceanographic Program  
Duke University Marine Laboratory

THE MONITOR'S TECHNOLOGICAL IMPORTANCE

Edwin B. Hooper, Vice Admiral, USN  
Director  
Naval Historical Center  
Department of Navy

NOMINATION AS A SANCTUARY

Mrs. Grace J. Rohrer  
Secretary, Department of Cultural Resources  
State of North Carolina

ADMINISTERING THE SANCTUARY

Mr. Robert W. Knecht  
Assistant Administrator for Coastal Zone Management  
National Oceanic and Atmospheric Administration

DESIGNATION AND REMARKS

Honorable Frederick B. Dent  
Secretary of Commerce

D E S I G N A T I O N

WHEREAS Title III of the Marine Protection, Research, and Sanctuaries Act of 1972, Public Law 92-532, authorized the Secretary of Commerce, with the approval of the President of the United States, to designate Marine Sanctuaries; and,

WHEREAS the wreckage of the USS Monitor has recently been identified; and,

WHEREAS it is the concensus of concerned organizations and individuals that the wreckage should be protected for its historic, cultural, and technological values; and,

WHEREAS the vessel has been placed on the National Register of Historic Places;

I, THEREFORE designate the site of the USS Monitor to be

THE MONITOR MARINE SANCTUARY

the area of which is to encompass a vertical section of the water column from the surface to the seabed and extending horizontally one mile in diameter from a center point located at 35°00'23" North Latitude and 75°24'32" West Longitude; and hereby affirm that the regulations promulgated according to the aforementioned authority will provide the necessary protection of law to preserve the esthetic values of this Historic Place.

January 30, 1975

Signature  
Frederick B. Dent  
Secretary of Commerce

MEMORANDUM OF UNDERSTANDING

Between

The National Oceanic and Atmospheric Administration (NOAA)  
and the Department of the Navy to provide for curatorship  
of the U.S.S. MONITOR Marine Sanctuary.

Pursuant to the Marine Protection, Research and Sanctuaries Act of 1972, Section 302(a), the Secretary of Commerce designated the site of the sunken U.S.S. MONITOR as a marine sanctuary to preserve the vessel's unique historic and cultural value. The Marine Protection, Research and Sanctuaries Act, Section 302(f) permits the Secretary of Commerce, authority delegated to Administrator (NOAA), to develop necessary and reasonable regulations to control any activities permitted within the designated marine sanctuary. The regulations promulgated require a permit to carry out research on the vessel. All other activities that may potentially damage the wreckage and lessen the historic and cultural value are prohibited.

It is anticipated that during the permitted study of the vessel various materials and information will be collected that will enhance the American people's appreciation of the values and will assist in further study of the vessel. Thus, one condition to acquisition of a research permit is that all documentation and materials gathered under the permit must be made available to the American people.

The United States Navy has established the Curator for the Department of the Navy and a system for the collection, organization, and preservation

of significant historical naval records and materials, and for making the materials and information available to the public. After careful analysis of the alternatives it was determined that the program structure under the Curator for the Department of the Navy is the most suitable mechanism to assure long-term control and availability of the documentation and artifacts accrued during study of the U.S.S. MONITOR.

Accordingly, the National Oceanic and Atmospheric Administration with the delegated responsibility of the Marine Protection, Research and Sanctuaries Act of 1972 and the Department of the Navy hereby agree the curatorial requirements of the U.S.S. MONITOR Marine Sanctuary will be conducted by the Department of the Navy.

This agreement does not involve a transfer of funds nor does it infer an additional expenditure by the Department of the Navy beyond utilization of existing mechanism to assure control of materials and information.

To provide information to the National Oceanic and Atmospheric Administration for the report to Congress required by Section 302(d) of the Marine Protection, Research and Sanctuaries Act of 1972, the Department of the Navy will provide an annual report of the artifacts and documentation accessioned during a 12-month period ending September 30.

Signature

Robert M. White  
Administrator, NOAA  
Department of Commerce

Signature

J. William Middendorf, II  
Secretary  
Department of the Navy

MEMORANDUM OF AGREEMENT

Between

the National Oceanic and Atmospheric Administration and the Department of Cultural Resources, State of North Carolina to establish and manage a distribution and evaluation system for proposals to conduct research investigations in the MONITOR Marine Sanctuary.

Regulations promulgated pursuant to Section 302(f) of the Marine Protection, Research and Sanctuaries Act of 1972 require a NOAA issued permit to conduct investigations and research in the MONITOR Marine Sanctuary.

The National Oceanic and Atmospheric Administration and the Department of Cultural Resources regarding the review of research proposals and issuances of a permit hereby agree to the following:

1. That administration of the review and evaluation of each proposal will be carried out by the Department of Cultural Resources, North Carolina State University, Department of Archaeology.

2. The individual responsible for the process will be entitled Coordinator for Technical and Governmental Review. The Coordinator is:

Dr. Kent A. Schneider  
Department of Archaeology  
North Carolina State  
Raleigh, North Carolina

3. The specific functions of the Coordinator are:
  - a. Receives all proposals
  - b. Distributes proposals for technical review
  - c. Collates and summarizes technical reviews
  - d. Distributes proposals and technical reviews and summary to government and quasi-governmental organizations for review.
  - e. Collates and summarizes governmental review and makes recommendation to the National Oceanic and Atmospheric Administration.
  - f. Disseminates permit or decision not to grant permit to applicant (the decision to grant or not to grant a permit resides with the Administrator of NOAA).
  - g. Contacts and maintains a list of approved technical reviewers.
4. That the review and evaluation system will be carried out by the Department of Cultural Resources at no cost to the Federal Government.
5. The technical review group will consist of active researchers or research managers capable of carrying out an indepth scientific review. Individuals who participate must agree to do so without reimbursement and with the approval of the National Oceanic and Atmospheric Administration. Approval may be granted after an individual has been suggested or requests to participate, has agreed in writing to participate and his or her scientific credentials are deemed appropriate. Failure to respond to a request to review a proposal will result in the individual no longer considered an approved reviewer.

6. Each proposal must be reviewed as a minimum by individuals competent in the discipline of:

Marine archaeology

Naval history

Oceanography

and other relevant disciplines as appropriate, including but not limited to:

Engineering

Anthropology

Geology

Metallurgy

Physics

Chemistry

Biology

Naval architecture

Presently approved reviewers appear in Appendix I.

7. The governmental and quasi-governmental agencies indicating an interest in reviewing proposals will receive copies of all proposals until they indicate they no longer have a continuing interest.

8. Each reviewer will be given a 30 day period for review. No response in this time period will be prima facia evidence that the proposals are acceptable.

The current governmental and quasi-governmental agencies appear in Appendix 2.

9. When a decision to grant a permit has been reached the Advisory Council for Historic Preservation will be notified of the pending action and proper documentation submitted to the Council according to Section 106 requirements of the National Historic Preservation Act of 1966.

10. Proposal applicants may appeal according to the regulations promulgated by the National Oceanic and Atmospheric Administration in the Federal Register. Appendix 3.

DEPARTMENT OF CULTURAL RESOURCES

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

APPENDIX I

Dr. Reynold J. Ruppe  
Department of Anthropology  
Arizona State University  
Tempe, Arizona

Mr. W. A. Cockrell  
State Underwater Archaeologist  
Division of Archives, History, and  
Records Management  
Tallahassee, Florida

Dr. William Still  
Department of History  
East Carolina University  
Greenville, North Carolina

Dr. Harold E. Edgerton  
Department of Electrical Engineering  
Massachusetts Institute of Technology  
Cambridge, Massachusetts

Mr. John Newton  
Marine Superintendent  
Duke University Marine Laboratory  
Beaufort, North Carolina

Dr. Thomas L. Linton  
Director  
Office of Marine Affairs  
Department of Administration  
Raleigh, North Carolina

Dr. James Harding  
Skiddaway Institute of Oceanography  
Savannah, Georgia

Dr. Phillip K. Lundeberg  
Curator  
Division of Naval History  
National Museum of History and Technology  
Smithsonian Institution  
Washington, D. C.

Professor Arthur Steinber  
Marine Metallurgist  
Massachusetts Institute of Technology  
Cambridge, Massachusetts

Mr. Aldin K. Woodward  
6 Tidewater Executive Center  
Norfolk, Virginia 23502

APPENDIX II

United States Navy, Director of Naval History

United States Coast Guard

State of North Carolina, Department of Cultural Resources

Department of the Interior

Department of State

Department of Justice

Smithsonian Institute, Eisenhower Institute

National Trust for Historic Preservation

National Science Foundation

Advisory Board on National Parks, Historic Sites,

Buildings and Monuments

APPENDIX III

TITLE 15 - Commerce and Trade

CHAPTER IV - National Oceanic and  
Atmospheric Administration  
Department of Commerce

Part 924, Interim Regulations Applicable to the MONITOR Marine Sanctuary, On \_\_\_\_ , 1975, the Secretary of Commerce designated as a marine sanctuary an area of the Atlantic Ocean around and above the submerged wreckage of the Civil War ironclad MONITOR pursuant to the authority of Section 302(a) of the Marine Protection, Research and Sanctuaries Act of 1972 (86 Stat. 1052, 1061, hereafter the Act). The sanctuary area (hereafter the Sanctuary) is about 16.10 miles south-southeast of the Cape Hatteras (North Carolina) Light.

Section 302(f) of the Act directs the Secretary to issue necessary and reasonable regulations to control any activities permitted within a designated marine sanctuary. This Section also provides that no permit, license, or other authorization issued pursuant to any other authority shall be valid unless the Secretary shall certify that the permitted activity is consistent with the purposes of TITLE III of the Act ("Marine Sanctuaries"); and that it can be carried out within the regulations promulgated under Section 302(f).

The authority of the Secretary to administer the provisions of the Act has been duly delegated to the Administrator, National Oceanic and Atmospheric Administration, U.S. Department of Commerce (hereafter The Administrator, \_\_\_\_ F.R. \_\_\_\_, \_\_\_\_, \_\_\_\_).

There are published herewith interim regulations relating to activities to be prohibited or permitted in the Sanctuary, and relating to the certification requirement described above. Comments upon these regulations are invited for a period of 45 days from the date of this publication. Comments should be addressed to the Administrator, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Washington, D.C. 20230. Following the close of this 45-day period, any comments received will be reviewed. In the discretion of the Administrator, these interim regulations will be amended so as to reflect any such comments. The Administrator shall then publish final regulations in the Federal Register. Pending the issuance of final regulations, these interim regulations are effective.

#### Part 924

- 924.1 Authority
- 924.2 Description of the Sanctuary
- 924.3 Activities Prohibited Within the Sanctuary
- 924.4 Penalties for Commission of Prohibited Acts
- 924.5 Permitted Activities
- 924.6 Permit Procedures and Criteria
- 924.7 Certification Procedures
- 924.8 Appeals of Administrative Action
- Section 924.1 Authority

The Sanctuary has been designated by the Secretary of Commerce pursuant to the authority of Section 302(a) of the Act. The following regulations are issued pursuant to the authorities of Sections 302(f), 302(g) and 303 of the Act.

Section 924.2 Description of the Sanctuary.

The Sanctuary consists of a vertical portion of the water column in the Atlantic Ocean one mile in diameter extending from the surface to the seabed and around and above the submerged wreckage of the MONITOR. The central point of the Sanctuary is about 16.10 nautical miles south-south-east of the Cape Hatteras (North Carolina) Light at the coordinates of 35° 00' 23" north latitude and 75° 24' 32" west longitude (See accompanying chart).

Section 924.3 Activities prohibited Within the Sanctuary.

Except as may be permitted by the Administrator, no person subject to the jurisdiction of the United States shall conduct any of the following activities in the Sanctuary:

- (a) bottom anchoring;
- (b) any type of salvage or recovery operation;
- (c) any type of diving, whether by an individual or by a submersible;
- (d) lowering any grappling, suction, conveyor, dredging or wrecking device;
- (e) detonation of any explosive or explosive mechanism;
- (f) seabed drilling or coring;
- (g) lowering, laying, positioning or raising any type of seabed cable or device;
- (h) bottom trawling.

Section 924.4 Penalties for Commission of Prohibited Acts.

Section 303 of the Act authorizes the assessment of a civil penalty of not more than \$50,000 for each violation of any regulation issued pursuant to TITLE III of the Act, and further authorizes a proceeding in-rem against any vessel used in violation of any such regulation. Details are set out in Subpart (D) of Part 292 of this Chapter (39 F.R. 232 54, 232 57, June 27, 1974). Subpart (D) is applicable in any instance of a violation of these regulations.

Section 924.5 Prohibited activities otherwise permitted.

Any person or entity may conduct in the Sanctuary any activity listed in Section 924.3 (hereafter a prohibited activity) provided that: (a) such activity is either (i) for the purpose of research related to the MONITOR, or (ii) is in connection with an air or marine disaster which has occurred in the vicinity of the Sanctuary; and (b) such person or entity is in possession of a valid permit issued by the Administrator authorizing the conduct of such activity; or (c) such activity is for the purpose of either (i) avoidance of an air or marine disaster, or (ii) rescue or relief after an air or marine disaster.

Section 924.6 Permit procedures and criteria.

(a) Any person or entity who wishes to conduct in the Sanctuary an activity for which a permit is authorized by Section 924.5 may apply in writing to the Administrator for a permit to conduct such activity citing this Section as the basis for the application. Such application should be made to the Administrator, National Oceanic and Atmospheric Administration, U. S.

Department of Commerce, Washington, D. C. 20230. Upon receipt of such application, the Administrator shall request, and such person or entity shall supply to the Administrator, such information and in such form as the Administrator may require to enable him to act upon the application. In any instance in which a permit is sought for the conduct of a prohibited activity in connection with a marine or air disaster which has occurred in or within the vicinity of the Sanctuary, application may be made to the Administrator by the most expeditious means, and subsequently confirmed in writing if not originally made in writing.

(b) In considering whether to grant a permit for the conduct of a prohibited activity for the purpose of research related to the MONITOR, the Secretary shall evaluate such matters as (i) the general professional and financial responsibility of the applicant; (ii) his particular fitness for the conduct for the research; (iii) the appropriateness of the research method(s) envisioned to the purpose(s) of the research; (iv) the extent to which the conduct of any prohibited activity may diminish the value of the MONITOR as a source of historic, cultural, aesthetic and/or maritime information; (v) the end value of the research envisioned; and (vi) such other matters as the Administrator deems appropriate.

(c) In considering whether to grant a permit for the conduct of a prohibited activity in the Sanctuary in relation to an air or marine disaster, the Administrator shall consider such matters as (i) the fitness of the applicant to do the work envisioned; (ii) the necessity of conducting such activity; (iii) the appropriateness of any activity envisioned to the purpose of the entry into the Sanctuary; (iv) the extent to which the conduct

of any such activity may diminish the value of the MONITOR as a source of historic, cultural, aesthetic and/or maritime information; and (v) such other matters as the Administrator deems appropriate.

(d) In considering any application submitted pursuant to this Section, the Administrator may seek and consider the views of any person or entity, within or outside of the Federal government, as he deems appropriate.

(e) The Administrator may, in his discretion, grant a permit which has been applied for pursuant to this Section, in whole or in part, and subject to such condition(s) as he deems appropriate, except that the Administrator shall attach to any permit granted for research related to the MONITOR the condition that any information and/or artifact(s) obtained in the research shall be made available to the public. The Administrator may observe any activity permitted by this Section; and/or may require the submission of one or more reports of the status or progress of such activity.

(f) A permit granted pursuant to this Section is nontransferrable.

(g) The Administrator may amend, suspend or revoke a permit granted pursuant to this Section, in whole or in part, temporarily or indefinitely, if, in his view, the permit holder (hereafter the Holder) has acted in violation of the terms of the permit; or the Administrator may do so for other good cause shown. Any such action shall be in writing to the Holder, and shall set forth the reason(s) for the action taken. Holder in relation to whom such action has been taken may appeal the action as provided in Section 924.6.

Section 924.7 Certification procedures.

Any Federal agency which, as of the effective date of these regulations, already has permitted, licensed or otherwise authorized any activity in the Sanctuary shall notify the Administrator of such action in writing, which writing shall include a reasonably detailed description of such activity, the person(s) involved, the beginning and ending dates of such permission, the reason(s) and purpose(s) for same, and a description of the total area affected. The Administrator shall then decide whether the continuation of the permitted activity, in whole or in part, or subject to such condition(s) as he may deem appropriate, is consistent with the purposes of Title III of the Act and can be carried out within these regulations. He shall inform the Federal agency of his decision in these regards, and the reason(s), and the reason(s) therefore, in writing. Upon receipt of the Administrator's decision, such Federal agency shall comply with that decision forthwith. The decision of the Secretary made pursuant to this section shall be final action for the purpose of the Administrative Procedure Act.

Section 924.8 Appeals of Administrative Action

(a) In any instance in which the Administrator, as regards a permit authorized by, or issued pursuant to, this Part: (i) denies a permit; (ii) issues a permit embodying less authority than was requested; (iii) conditions a permit in a manner unacceptable to the applicant; or (iv) amends, suspends, or revokes a permit for a reason other than the violation of regulations issued under this Part, the applicant or the permit

holder, as the case may be (hereafter the Appellant), may appeal the Administrator's action to the Secretary. In order to be considered by the Administrator, such appeal shall be in writing, shall state the action(s) appealed and the reason(s) therefore, and shall be submitted within 30 days of the action(s) by the Administrator to which the appeal is directed. The Appellant may request a hearing on the appeal.

(b) Upon receipt of an appeal authorized by this Section, the Secretary may request, and if he does, the Appellant shall provide, such additional information and in such form as the Secretary may request in order to enable him to act upon the appeal.

If the appellant has not requested a hearing, the Secretary shall decide the appeal upon (i) the basis of the criteria set out in Section 924.6(b) or Section 924.6(c), as appropriate, (ii) information relative to the application on file in NOAA, (iii) information provided by the Appellant, and (iv) such other considerations as he deems appropriate. He shall notify the Appellant of his decision, and the reason(s) therefore, in writing within 30 days of the date of air receipt of the appeal.

(c) If the Appellant has requested a hearing, the Secretary shall grant an informal hearing before a Hearing Officer designated for that purpose by the Secretary after first giving notice of the time, place, and subject matter of the hearing in the Federal Register. Such hearing shall be held no later than 30 days following the Secretary's receipt of the appeal. The Appellant and any interested person may appear personally or by counsel at the hearing, present evidence, cross-examine witnesses, offer argument and file a brief. Within 30 days of the last day of the hearing, the

Hearing Officer shall recommend in writing a decision to the Secretary based upon the considerations outlined in subsection (b) above and based upon the record made at the hearing.

(d) The Secretary may adopt the Hearing Officer's recommended decision, in whole or in part, or may reject or modify it. In any event, the Secretary shall notify the Appellant of his decision, and the reason(s) therefore, in writing within 15 days of his receipt of the recommended decisions of the Hearing Officer. The Secretary's action, whether without or after a hearing, as the case may be, shall constitute final action for the purposes of the Administrative Procedure Act.

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) <b>United States. Naval Academy, Annapolis.</b>		2a. REPORT SECURITY CLASSIFICATION <b>UNCLASSIFIED.</b>	
		2b. GROUP	
3. REPORT TITLE <b>Project cheesebox : a journey into history; a research manuscript.</b>			
4. DESCRIPTIVE NOTES (Type of report and inclusive dates) <b>Research report.</b>			
5. AUTHOR(S) (First name, middle initial, last name)			
6. REPORT DATE <b>December 1974.</b>		7a. TOTAL NO. OF PAGES <b>3 v., 1103 p.</b>	7b. NO. OF REFS <b>254.</b>
8a. CONTRACT OR GRANT NO.		9a. ORIGINATOR'S REPORT NUMBER(S) <b>U.S. Naval Academy, Annapolis. Dept. of History. Research manuscript; Project Cheesebox.</b>	
b. PROJECT NO.		9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report)	
c.			
d.			
10. DISTRIBUTION STATEMENT <b>This document has been approved for public release; its distribution is UNLIMITED.</b>			
11. SUPPLEMENTARY NOTES <b>Authorship is mixed in character.</b>		12. SPONSORING MILITARY ACTIVITY <b>United States. Naval Academy, Annapolis.</b>	
3. ABSTRACT <p>The work is a multi-disciplined research project conducted at the U.S. Naval Academy and it was initiated by Midshipmen to study the history of the Civil War "Ironclad" <u>USS Monitor</u>. → <i>next page</i></p> <p>The project was divided into three phases: 1/ the first phase is the documentation of the history of the Ironclad and its inventor John Ericsson;</p> <p>2/ phase two was the construction of two scale models: one is a tow tank model for testing; the other one is a cutaway model showing particulars of construction and interior details;</p> <p>3/ the phase three was the development of search techniques and procedures to be used in searching for the lost hulk of the Monitor. Technical assistance was given by the Naval Ship Research and Development Center and by the research vessel Alcoa Seaprobe.</p> <p>Documents, detailed descriptions with illustrations have been given in this 3 volumes report.</p>			

UNCLASSIFIED.

Security Classification

Vol. 3 of 3 vols.

DOCUMENT CONTROL DATA - R & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

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13. ABSTRACT

The work is a multi-disciplined research project conducted at the U.S. Naval Academy and it was initiated by Midshipmen to study the history of the Civil War <sup>\*\*\*</sup>Ironclad<sup>\*\*</sup> USS Monitor. → next page

The project was divided into three phases:

1/ the first phase is the documentation of the history of the Ironclad and its inventor John Ericsson;

2/ phase two was the construction of two scale models: one is a tow tank model for testing; the other one is a cutaway model showing particulars of construction and interior details;

3/ the phase three was the development of search techniques and procedures to be used in searching for the lost hulk of the Monitor. Technical assistance was given by the Naval Ship Research and Development Center and by the research vessel Alcoa Seaprobe.

Documents, detailed descriptions with illustrations have been given in this 3 volumes report.

→ This volume documents the development  
of a scale model for test of  
seaworthiness of original Ironclad.  
It also lists the research techniques  
which led to the discovery of  
the lost hull of the Monitor,  
and the exploration of the  
site. ←