OPERATIONS MANUAL

MONITOR MARINE SANCTUARY AN ARCHAEOLOGICAL AND ENGINEERING ASSESSMENT

AUGUST 1979

U.S. DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

Coastal Zone Management

Cover: Drawing shows diver conducting the test excavation inside the wreck, just aft the bow, using an induction dredge to remove sand and debris (p. 5). An aluminum frame deliniates the five-foot-square excavation site. The Johnson-Sea-Link II (right) is in constant communication with the diver (p. 36). On the left is the unmanned submersible, CORD II, hovering near the diver and video taping the entire operation (p. 34).

(Drawing courtesy of the North Carolina Division of Archives and History)

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Sponsored by
Office of Coastal Zone Management
National Oceanic and Atmospheric Administration
in cooperation with
Harbor Branch Foundation, Incorporated
and North Carolina Department of Cultural Resources

August 1979

U.S. DEPARTMENT OF COMMERCE
Juanita M. Kreps, Secretary
National Oceanic and Atmospheric Administration
Richard A. Frank, Administrator
Coastal Zone Management
Robert W. Knecht, Assistant Administrator

MONITOR MARINE SANCTUARY

OPERATIONS MANUAL

This Operations Manual satisfies the requirements of NOAA Circular 78.31 (June 1, 1978) entitled Leasing and Operation of Submersibles and NOAA Circular 74-62 (August 12, 1974) entitled NOAA Diving Regulations.

6/4/79
Date

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6/4/79
Date

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13 May 1979
Date

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*NOTE: This approval is subject to compliance with the guidelines set forth with respect to surface support vessels in the OA/C7 memo of June 1, 1979, appended hereto as new Appendix 6.

6/4/79

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SUMMARY - NOAA

On January 30, 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 U.S.S. MONITOR pursuant to the authority of the Marine Protection, Research and Sanctuaries Act of 1972.

The National Oceanic and Atmospheric Administration, Office of Coastal Zone Management and Harbor Branch Foundation, Inc., have agreed to undertake a cooperative project, with the participation of North Carolina, at the MONITOR Marine Sanctuary to achieve the following objectives:

- Establish permanent datum control points
- Conduct a test excavation
- Photograph portions of the wreck
- Undertake an attitude analysis of the hull structure
- Conduct structural testing of structural components of the wreck

OFFICE OF COASTAL ZONE MANAGEMENT

The National Oceanic and Atmospheric Administration (NOAA), Office of Coastal Zone Management (OCZM) was established to administer the Coastal Zone Management Act of 1972 (P. L. 92-583). In addition, the Secretary of Commerce delegated the authority to OCZM to administer Title III of the Marine Protection, Research and Sanctuaries Act of 1972 (P. L. 92-532).

The authority granted under Title III sets 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.

OCZM has taken an active role in the management of the MONITOR Marine Sanctuary. To effectively manage the site, there must be an understanding of the wreck's condition and environment resulting in OCZM's active involvement in the research that takes place.

HARBOR BRANCH FOUNDATION, INC.

The Harbor Branch Foundation, Inc. (HBF), is a not for profit corporation established in 1970 primarily for research in the marine sciences and for the development of oceanographic tools and systems for undersea research and archaeology. Outlined below are HBF's program objectives:

1. Accumulating and computerizing knowledge in the field of oceanology, particularly as it applies to the effects of pollution.

2. Sponsoring and engaging in scientific research and development for the purpose of making inventories and observing the behavior of marine plants and animals through various stages of their life cycles in unpolluted and polluted areas.

3. Developing new engineering tools and improved safety equipment for marine and oceanographic research and operating laboratories for the furtherance of such research.

4. Developing methods for changing the character of pollution, by eliminating its harmful effects and by utilizing its nutrients and beneficial effects.

5. Sponsoring and engaging in underwater archaeology projects through the use of new engineering tools and methods.

6. Preparing and distributing publications, research materials, lectures, and seminars which serve to disseminate knowledge of marine plants and animals and ocean engineering research development.

In August of 1977, HBF was the major contributor to the expedition that took place at the MONITOR Marine Sanctuary. The main emphasis in that project was to obtain controlled stereo photographs of the wreck stereographically. In addition to this, a hull plate and brass marine lantern were recovered from the site.

HBF provided personnel, surface and underwater vessels, and equipment which resulted in a high successful operation.

For this expedition, HBF will again provide personnel, surface and underwater vessels, and equipment to meet the operational requirements.

NORTH CAROLINA DEPARTMENT OF CULTURAL RESOURCES

The State of North Carolina has been actively involved with the U.S.S. MONITOR since its discovery in 1973. NOAA (OCZM) has worked closely with the Division of Archives and History within the Department of Cultural Resources. Since 1975, when the site was designated a Marine Sanctuary, a Memorandum of Understanding has existed between NOAA and North Carolina for the purpose of reviewing proposals and providing technical assistance.

The Underwater Archaeology Research Unit provided technical assistance in the development of the proposal for this expedition. Further, the State Underwater Archaeologist and his staff will provide the following support to the project:

1. The on site Archaeologist who is responsible for insuring the techniques involved with the operations do not damage the integrity of the wreck.

2. Divers to assist in the installation of the control points, to conduct the test excavation, to make attitude measurements and to photograph portions of the wreck.

3. Equipment necessary to install the control datum points, to complete the test excavation, and to conduct the attitude analysis.

4. On site stabilization and packaging and transportation of recovered artifacts from the site to the preservation laboratory.

I. MISSION OBJECTIVES

The project has been designed to accomplish five major objectives: the establishment of permanent datum control points, test excavation, photography, attitude analysis, and structural testing. It is expected that these will provide presently unavailable information essential to the development of responsible management policies for the MONITOR Marine Sanctuary. Following are descriptions of each objective:

A. ESTABLISH PERMANENT DATUM CONTROL POINTS

Both analysis of existing photographic records and continued systematic investigation in the Marine Sanctuary require that a master reference system be installed to control data collecting activities (e.g., photography, mapping, excavation, sampling, and testing). A master reference system consisting of ten permanent provenience stations can be effectively utilized to provide the desired control. The primary objective of the expedition will be to establish four stations that will serve as the nucleus of this reference system (Figure 1 and 5). The remaining six stations will be installed at a later date.

By utilizing a system consisting of ten datum stations that encompass the major concentration of vessel remains with a 200 x 60 foot rectangle, accurate provenience data can be established both inside the wreck and anywhere in the immediate environment. In addition to forming the nucleus of a comprehensive on site grid system to support extended investigations, these stations will provide accurate and accessible control points for trilateration where sampling activities do not merit extensive permanent references.

The system can be employed for both conventional mechanical surveying and mapping methods and/or electronic/acoustic positioning systems. Because the control stations are located outside the remains of the vessel, they can be utilized to control post-recovery investigations of the site in the event that the MONITOR is moved.

The initial stations will consist of four non-corrosive ten foot pipe casings which will be set vertically six to eight feet into the bottom sediments (Figure 11 and 12) using moderate water pressure provided by a pump mounted on the submersible (Figure 13). Stations will be located by use of a positioning harness (Figure 14). The harness will be positioned in relation to predetermined points at the bow and turret. This will assure that initial stations are set approximately parallel to the keel and the rectangle formed by the completed system encompasses the major concentration of vessel remains. A levelling collar designed to fit the casings will permit each station to be installed with vertical accuracy (Figure 15). Once the stations have been set into position, an arbitrary elevation will be established and identified on each casing using a bubble level (Figure 16). A pressure guage will be used to correlate depth with the established elevation. In the event the jetting system does not work an alternative method of installing the control points will entail the use of san anchors.

B. TEST EXCAVATION

Numerous questions concerning the nature and extent of the archaeological record preserved at the MONITOR site have been posed. Because the site has never been tested, no answer can be provided and the feasibility of conducting systematic investigations at the site has not been established. Methods and techniques for conducting extended archaeological investigations below 200 feet from sophisticated diver delivery systems remain untested, and data return has yet to be weighed in light of the expense of such operations. To provide answers to these and a myriad of other engineering, conservation, and historical questions, a test excavation will be carried out inside the confines of the hull.

Analysis of the existing photographic data indicates that the most appropriate area for test excavation is immediately inboard of the port armor belt, aft of the bow, on the north side of the wreck (Figures 2 and 5). This area does not appear to contain hull plates or other structural elements, indicating that limited excavation might be successfully carried to deck timber. With the exception of the pilot house area this is the only part of the wreck that appears to be relatively clear of hull structure. The surface presence of material identified historically as having been stowed immediately above the bilge ceiling appears to confirm this hypothesis. However, the precise location of the 5 x 5 foot test excavation will be determined following a thorough reconnaissance of the area by an archaeologist at the beginning of the mission.

When the location for testing has been determined, grid frame will be set up over the 5 x 5 foot test site to control excavation and document its progress (Figures 17, 18 and 22). Once its position has been tied to the provenience stations and an elevation transferred, the grid will be used to reference all data collected. Excavation will be carried out by hand, with a 3-inch induction dredge powered by a pump on the submersible utilized to dispose of silt and overburden (Figure 23). As the excavation progresses, exposed artifacts will be mapped in situ using a camera mounted to the grid frame (Figures 19, 20, 21 and 22). Critical elevations will be made using a modified bubble level, and the excavators' observations will be recorded on tape during each dive. Once the necessary provenience data have been recorded, exposed artifacts will be removed, tagged, and placed in containers on the bottom pending transportation to the surface (Figure 24). At this point the excavation, documentation, and recovery process will begin again and proceed systematically until deck timber has been exposed.

By closely scheduling the excavation around a photograph, excavation, photograph, recovery, and photograph sequence, it will be possible to assure maximum efficiency and recording accuracy. Sequencing each dive in this manner will permit photographs of material exposed by excavation to be developed and checked prior to the removal of artifacts. In the event that there are problems in documentation, additional photographs will be the first priority of the next dive. This system aand closed circuit television monitoring of the excavation in progress will permit each member of the excavation team to maintain a constant awareness of all on site progress and increase the efficiency of orientation sessions between dives.

In addition to recording on site observations on tape, the excavation team will log significant details on submersible writing slates. Information from each slate will be transferred to a permanent log containing records of all significant observation during decompression. Rough transcripts of the on site tapes will be prepared prior to each individual's next dive to reduce the possibility of errors. Maps of the excavation and a catalog of recovered materials will be updated on a daily basis.

Upon completion of the excavation, photographs of the exposed deck beams and timber will be made to record details, and samples of the wood will be taken using an auger. Samples holes will be plugged with treated wood or plastic, to prevent or retard deterioration that might be accelerated by excavation activities, the test pit will be lined with plastic and filled with sand from outside the wreck using the induction dredge.

C. PHOTOGRAPHY

To assist in developing more comprehensive engineering evaluations of the condition of the wreck, to help answer historical questions about the ship's design and construction, and as an aid in assessing conservation problems that the wreck presents, hand-held photographic and video tape records will be prepared. Video and photo recording will concentrate on exposed areas of the deck, the turret/hull relationship, damage to the stern, and the engineering spaces aft of the amidships bulkhead. In addition to providing general insight into each of these areas, attention will be devoted to recording details necessary to answering specific questions (Figures 3 and 5).

D. ATTITUDE ANALYSIS

At preselected locations along the port and starboard armor belt, amidships bulkhead, and lower hull, measurements will be made to assist in determining the degree of list and ptich of the hull (Figure 4). With sufficient data it is hoped that the presence of stress-related distoration can be detected. Measurements will be made using an inclinometer designed for the project (Figure 25).

E. STRUCTURAL TESTING

Where the excavation exposes deck beams and decking, small samples of the structural wood will be recovered for analysis and testing. Additional samples will be taken along the bottom of the armor belt where deterioration of the iron permits. These samples will provide the first evidence of the present condition of structural wood in the hull. Each sample will be replaced with non-corrosive neutral material (e.g., wood, plastic) to prevent any additional damage to the remains of the vessel.

II. OVERVIEW OF THE OPERATION

The Marine Sanctuary consists of a water column in the Atlantic Ocean one mile in diameter extending from the surface to the seabed the center of which is 35°00'23" north latitude and 75°24'32" west longitude or approximately 16.10 miles south-southeast of Cape Hatteras Light (North Carolina).

The mission consists of five objectives, as described in Section I, and will begin on August 1, 1979, lasting 28 days. All work, with the exception of general reconnaissance, will involve submersible and lock-out diving operations. Completion date of the mission is projected to be August 28, 1979.

III. MISSION PLAN

A. OPERATING AREA

Figure 6 shows the area in the Atlantic Ocean where the MONITOR is located. The onshore base of operations will be located in Hatteras, North Carolina. The docking facility will be at:

U.S. Coast Guard Station, Hatteras, N.C. - The SEA GUARDIAN will be deployed from the Coast Guard station and stored there when not needed at the MONITOR site. A NOAA vessel will be available for daily transportation from Hatteras, N.C. to the R/V JOHNSON

The physical characteristics of the area will be reviewed during the reconnaissance phase of the mission. Present information describes the characteristics as follows:

Depth - Water depth at the MONITOR is between 200 ft. and 210 ft.

Currents - The bottom currents are highly variable at the site. The only measurements of bottom currents made by the University of Delaware in April 1977 showed a maximum velocity of 0.4 knots.

Obstacles - The only known obstacle in the sanctuary, based upon extensive side scan sonar, fathometer records and photographic data, is the wreck of the U.S.S. MONITOR.

Temperature - During July and August water temperature will range from 20°C to 23°C.

Bathymetry - The bottom slopes gently down from the north to the south in the sanctuary and can be described as a plateau.

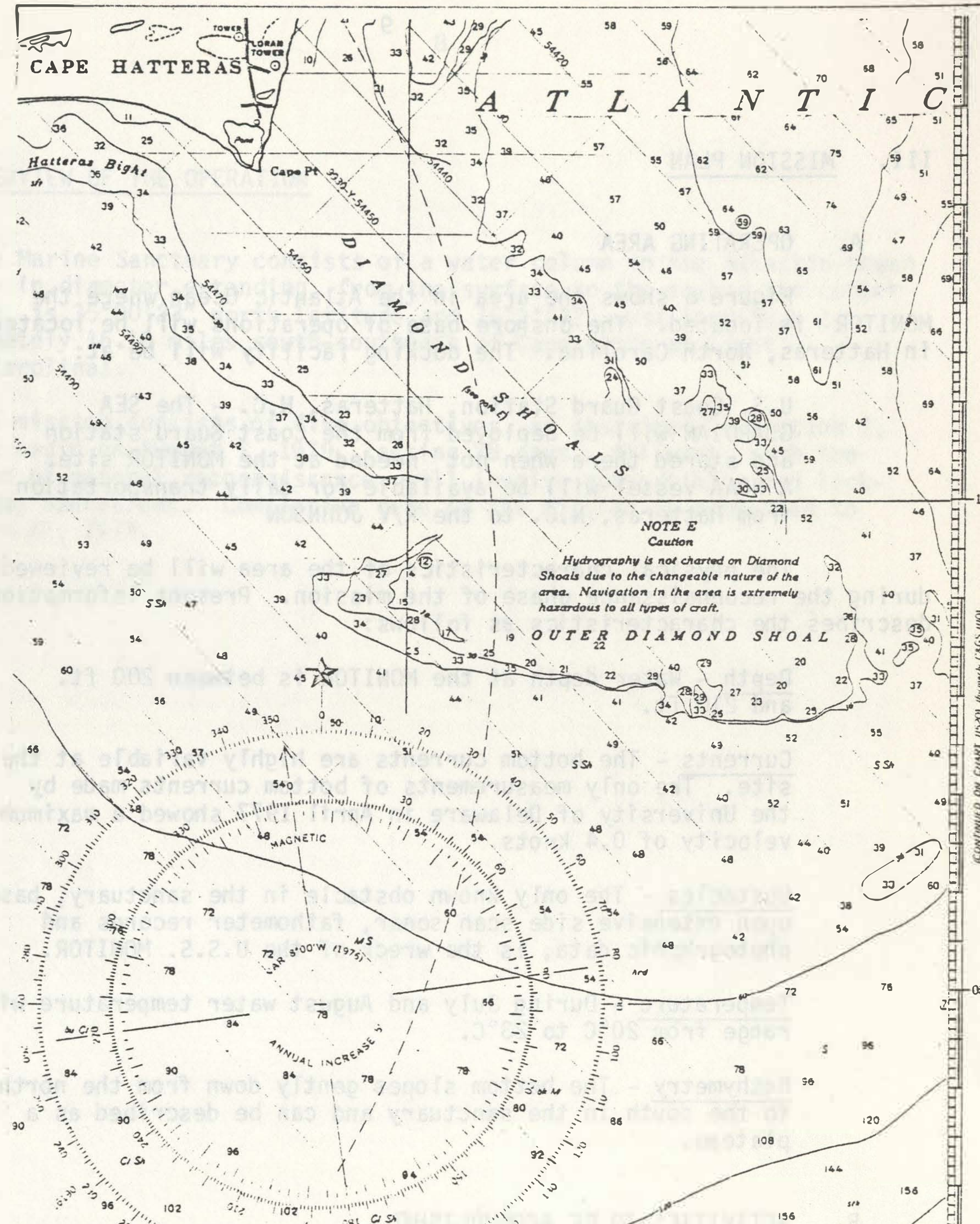
B. ACTIVITIES TO BE ACCOMPLISHED

1. Operational Tasks

The following sequence of operational tasks are scheduled:

- Installation of anchored buoy for intermittent use by SEA GUARDIAN.

FIGURE 6



PROJECT AREA

- Deployment of SEA GUARDIAN/CORD to collect TV photographic and current data; primary purpose is to survey area for hazards to manned submersible operations.
- General reconnaissance of the wreck and adjacent areas by submersible to check previously collected data (from CORD); archaeologist and engineers will observe to aid in design of later dives.
- Installation of four permanent control datum points on north side of wreck.
- Conduct test excavation in the forward section of the wreck. Excavation will take place in a 5 x 5' area.
- Conduct photographic documentation of the damaged area in the stern, engineering spaces and deck surface near the turret.
- Take wood samples for structural testing from deck beams, if exposed during excavation.
- Conduct attitude analysis of the wreck using inclinometer.

2. Scientific Tasks

During the entire mission, environmental data will be collected by the surface vessel and submersible. Specific information to be collected is listed on the log form in (Figure 7a, b).

C. TRAINING REQUIREMENTS

Gordon Watts and Richard Lawrence of the State of North Carolina Department of Underwater Archaeology and John Broadwater of the State of Virginia were trained in the use of HBF equipment and procedures for lock-out diving. The training was conducted at the HBF facility, Ft. Pierce, Florida and off West End, Grand Bahama Island from April 23 to May 3, 1979. Other HBF personnel were also trained during this same period.

The following is a general list of equipment, procedures and diving experience included during this training period.

- Review of purpose and function of all dive chamber equipment systems.

- Review of selected portions of the Navy Diving Manual relating to physiology and emergency procedures.

- Introduction and familiarization to the KMB-10 helmet.

- Constant review of fire and decompression procedures.

- Chamber dive to 60 ft. in deck decompression chamber aboard R/V JOHNSON. (This exercise provided insight to potential ear problems and permitted introduction to the 90/10 helium oxygen gas.)

- Two to three lock-out dives daily at depth ranging from 20-55 feet. (Each lock-out dive was designed to provide experience with the system and familiarity with emergency and safety procedures.)

- Exposure to simulated emergencies including loss of breathing gas, high pressure regulator failure and tender incapacitation.

- Chamber dive to 180 feet made to simulate decompression in deck chamber aboard R/V JOHNSON.

Upon completion of the training, Watts, Lawrence, and Broadwater were certified by HBF for use of the equipment for the MONITOR Project.

Figure 7a

Bridge Log

- Form should be filled out on an hourly basis when submersible is not in use.

- When submersible is in use log form should be filled out every 30 minutes. This should be done in conjunction with submersible.

- Form should be filled out to note any special changes in weather or sea conditions.

Bridge Log

Vessel - ______________

Day - Julian Day

Time - GMT

GP - Lat. and Long.

Temp. - Air - ________°C
Surface water - __________°C

Wind - Speed - __________kts
Directory - _______°T

Visibility - __________NM

Current (surfact) - Speed - __________KTS
Directory - _______°t

Sea state - Height
Direction

Remarks

Figure 7b

Submersible Log

- Should be filled out when submersible first reaches the bottom and then every thirty minutes.

- Form should also be filled out just before assent.

- Form should be filled out when any notable conditions change.

Submersible Log

Vessel - ____________

Day - Julian Day

Time - GMT

GP - In relationship to wreck

Dept. - ________ ft.

Temp. - ________ °C

Visibility - ______ ft.

Current - Speed - ________ kts
Direction ______ °t

Task being accomplished -

Remarks

D. DAILY SCHEDULE

Figure 8 outlines the daily ship operations and Figure 9 outlines the daily mission schedule.

Due to the number of lock-out dives scheduled, plans have been made to replenish the HeO2 banks on the R/V JOHNSON during bad weather days. This will take place at the Beaufort Marine Laboratory in Beaufort, N.C.

1. Outline of Operations Plan:

DAY	DIVE	PURPOSE
29 July		SEA GUARDIAN and CORD depart Link Port via commercial carrier.
30 July		R/V JOHNSON and R/V SEA DIVER depart Link Port, Florida with J-S-L I and II.
31 July		SEA GUARDIAN/CORD arrive Hatteras Inlet to be off-loaded by crane. The rest of the day will be spent field testing the system in the harbor and include checks of CORD's propulsion, TV camera, manipulator and associated controls aboard the SEA GUARDIAN.
1 August		R/V JOHNSON will rendezvous with SEA GUARDIAN/ CORD at the sea buoy in Hatteras Inlet and the system will be towed to the MONITOR site.
1	01	General reconnaissance and assessment of proposed baseline location. 1/
2	02	General engineering reconnaissance and survey.

NOTE: Two lock-out dives will be directed by an Engineer on site.

1/ All underwater work will be done by HBF divers, Gordon Watts and Richard Lawrence of the State of North Carolina and John Broadwater of the State of Virginia.

DAY	DIVE	PURPOSE
	03	Deploy baseline harness along northside of wreck and unload casings, collar and jetting equipment.
3	04	Jet baseline casings into sediment at locations 1 and 2.
	05	Jet baseline casings into sediment at locations 3 and 4.
4	06	Jet baseline casings into sediment at location 5 and establish elevation.
	07	Baseline contingency or photographic/video recording of excavation area. 1/
5	08	Complete establishing datum control points if necessary; conduct hull orientation trilateration.
	09	Photographic documentation of relationship of turret to hull; conduct photographic documentation of damage to the stern.
6	10	Reconnaissance of test excavation area.
	11	Carry out photographic documentation of the engineering space; carry out photographic documentation of the desk surface.
7	12	Photographic excavation area position, set up and level test excavation grid frame. Establish and transfer to excavation grid frame arbitrary elevation; deploy video camera system.
	13	Photographic excavation surface for mapping; deploy induction dredge; clean away surface sediment and silt.

1/ To insure that enough time is allotted for each task to be completed, contingency days have been incorporated into the operational plan to take into account mechanical failures and bad weather.

DAY	DIVE	PURPOSE
8	14	Photograph excavation for mapping; excavate first level to expose material.
	15	Photograph excavation for mapping; excavate first level to expose material.
9	16	Photograph excavation for mapping; excavate first level to expose material and record evaluations.
	17	Photograph excavation for mapping; remove exposed material; tag artifacts and pack in basket for recovery.
10	18	Photographic excavation for mapping; remove exposed material; excavate second level to expose material.
10	19	Photograph excavation for mapping; excavate second level to expose material.
11	20	Photograph for mapping; excavate second level to expose material and record elevations.
	21	Excavation contingency engineering assessment and historical photography and VTR.
12	22	Excavation contingency; engineering and historical assessment photography and VTR.
	23	Excavation contingency; engineering and historical assessment. Photography and VTR.
13	24	Photograph for mapping; remove artifacts and samples; pack and dispatch recovery basket.
	25	Photograph excavation for mapping; remove exposed material; excavate third level to expose material.

DAY	DIVE	PURPOSE
14	26	Photograph excavation for mapping; remove exposed material; excavate third level to expose material.
	27	Photograph excavation for mapping; remove exposed material; excavate third level to expose material.
15	28	Photograph excavation for mapping; record elevations, remove and tag exposed material, pack and dispatch recovery basket.
	29	Third level excavation contingency or photograph excavation for mapping; remove exposed material; excavate fourth level to expose material.
16	30	Excavation contingency/engineering assessment. Photograph and VTR.
	31	Excavation contingency/engineering assessment. Photograph and VTR.
17	32	Photograph excavation for mapping, excavate fourth level to expose material.
	33	Photograph excavation for mapping; excavate fourth level to expose material.
18	34	Photograph for mapping; excavate fourth level to expose material.
	35	Photograph for mapping and record elevations; recover and tag exposed artifacts; pack and dispatch recovery basket.
19	36	Excavation contingency/engineering and historical assessment photography and VTR. Turret/hull.
	37	Engineering assessment/historical photography and VTR amidships bulkhead.

DAY	DIVE	PURPOSE
20	38	Attitude analysis data collection
	39	Attitude analysis data collected/ or structural samples.
21	40	Photograph excavation for mapping; excavate fifth level to expose material.
	41	Photograph excavation for mapping; excavate fifth level to expose material.
22	42	Photograph excavation for mapping; excavate fifth level to expose material.
	43	Photograph for mapping; record elevations; recover and tag exposed material; pack and dispatch recovery basket.
23	44	Excavation contingency; recovery of material. Photograph excavation for mapping; excavate sixth level to expose material.
	45	Photograph excavation for mapping; excavate sixth level to expose material.
24	46	Photograph excavation for mapping; excavate sixth level to expose material.
24	47	Photograph for mapping; excavate sixth level to expose material; record elevations; recover exposed material; pack and dispatch recovery basket.
25	48	Excavation contingency; recovery of material.
	49	Excavation contingency and collection of structural samples; profile photography excavation stabilization.

DAY	DIVE	PURPOSE
26	50	Excavation stabilization. Equipment recovery.
	51	Excavation stabilization. Equipment recovery.
27		Contingency day.
28		Contingency day.

2. Outline of Personnel Associated With Dives:

DAY	DIVE	PERSONNEL
1	1	Submersible - J-S-L I Pilot - Askew Observer - Watts Diver - Broadwater Tender - Mitchell
2	2	Pilot - Cook Observer - Searle Diver - Watts Tender - Melton
2	3	Pilot - Cook Observer - Broadwater Diver - Watts Tender - Roesch
3	4	Pilot - Askew Observer - Broadwater Diver - Lawrence Tender - Mitchell

DAY	DIVE	PERSONNEL SCHEDULE
3	5	Pilot - Askew Observer - Watts Diver - Broadwater Tender - Melton
4	6	Pilot - Cook Observer - Lawrence Diver - Watts Tender - Roesch
4	7	Pilot - Cook Observer - Broadwater Diver - Mitchell * Tender - Shafer
5	8	Pilot - Askew Observer - Watts Diver - Lawrence Tender - Melton
5	9	Pilot - Askew Observer - Broadwater Diver - Watts Tender - Roesch
6	10	Pilot - Cook Observer - Lawrence Diver - Broadwater Tender - Mitchell
6	11	Pilot - Cook Observer - Watts Diver - Melton * Tender - Shafer
7	12	Pilot - Askew Observer - Broadwater Diver - Watts Tender - Roesch
7	13	Pilot - Askew Observer - Lawrence Diver - Broadwater Tender - Mitchell
8	14	Pilot - Cook Observer - Watts Diver - Lawrence Tender - Melton
8	15	Pilot - Cook Observer - Broadwater Diver - Watts Tender - Roesch
9	16	Pilot - Askew Observer - Lawrence Diver - Broadwater Tender - Mitchell
9	17	Pilot - Askew Observer - Watts Diver - Lawrence Tender - Melton
10	18	Pilot - Cook Observer - Broadwater Diver - Watts Tender - Roesch
10	19	Pilot - Cook Observer - Lawrence Diver - Broadwater Tender - Mitchell
11	20	Pilot - Askew Observer - Watts Diver - Lawrence Tender - Melton
11	21	Pilot - Askew Observer - Watts Diver - Roesch * Tender - Shaffer
12	22	Pilot - Cook Observer - Broadwater Diver - Watts Tender - Mitchell
12	23	Pilot - Cook Observer - Lawrence Diver - Broadwater Tender - Melton
13	24	Pilot - Flake Observer - Watts Diver - Lawrence Tender - Roesch

DAY	DIVE	PERSONNEL SCHEDULE
13	25	Pilot - Flake
		Observer - Broadwater
		Diver - Watts
		Tender - Mitchell
14	26	Pilot - Prentice
		Observer - Lawrence
		Diver - Broadwater
		Tender - Melton
14	27	Pilot - Prentice
		Observer - Watts
		Diver - Lawrence
		Tender - Roesch
15	28	Pilot - Flake
		Observer - Broadwater
		Diver - Watts
		Tender - Hayes
15	29	Pilot - Flake
		Observer - Lawrence
		Diver - Broadwater
		Tender - Berg
16	30	Pilot - Prentice
		Observer - Lawrence
		Diver - Shafer *
		Tender - Bond
16	31	Pilot - Prentice
		Observer - Watts
		Diver - Lawrence
		Tender - Hayes
17	32	Pilot - Askew
		Observer - Broadwater
		Diver - Watts
		Tender - Berg
17	33	Pilot - Askew
		Observer - Lawrence
		Diver - Broadwater
		Tender - Bond
18	34	Pilot - Cook
		Observer - Watts
		Diver - Lawrence
		Tender - Hayes

DAY	DIVE	PERSONNEL SCHEDULE
18	35	Pilot - Cook
		Observer - Broadwater
		Diver - Watts
		Tender - Berg
19	36	Pilot - Askew
		Observer - Broadwater
		Diver - Shafer *
		Tender - Bond
19	37	Pilot - Askew
		Observer - Watts
		Diver - Broadwater
		Tender - Hayes
20	38	Pilot - Cook
		Observer - Lawrence
		Diver - Watts
		Tender - Berg
20	39	Pilot - Cook
		Observer - Broadwater
		Diver - Lawrence
		Tender - Bond
21	40	Pilot - Askew
		Observer - Watts
		Diver - Broadwater
		Tender - Hayes
21	41	Pilot - Askew
		Observer - Lawrence
		Diver - Watts
		Tender - Berg
22	42	Pilot - Cook
		Observer - Broadwater
		Diver - Lawrence
		Tender - Bond
22	43	Pilot - Cook
		Observer - Watts
		Diver - Broadwater
		Tender - Hayes
23	44	Pilot - Askew
		Observer - Lawrence
		Diver - Watts
		Tender - Berg

DAY	DIVE	PERSONNEL SCHEDULE
23	45	Pilot - Askew Observer - Broadwater Diver - Lawrence Tender - Bond
24	46	Pilot - Cook Observer - Watts Diver - Broadwater Tender - Hayes
24	47	Pilot - Cook Observer - Lawrence Diver - Watts Tender - Berg
25	48	Pilot - Askew Observer - Broadwater Diver - Lawrence Tender - Bond
25	49	Pilot - Askew Observer - Watts Diver - Broadwater Tender - Hayes
26	50	Pilot - Cook Observer - Lawrence Diver - Watts Tender - Berg
26	51	Pilot - Cook Observer - Broadwater Diver - Lawrence Tender - Bond

FIGURE 8

DAILY SHIP OPERATIONS SCHEDULE

```
                        JULY                                   AUGUST
                       30 31  1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28

R/V JOHNSON                   X-----------------------------------------------------------------------------X

R/V SEA DIVER                                                  X-------X

JSL I                         X-----------------------------------------------------------------------------X

JSL II                                                         X-------X

SEA GUARDIAN/CORD             X-----------------------------------------------------------------------------X
```

FIGURE 9

DAILY OPERATIONS MISSION

	July 30	31	August 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Staging-Hatteras N.C.	X	X																														
Sea Guardian/CORD Reconnaissance & Photography			X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X		
JSL I- Installation of Control Datum Points			X	-	-	-	X																									
JSL I- Test Excavation								X	-	-	-	-	-	-	-	-	-	-	-	-	X		X	-	-	-	-	X				
JSL I- Photographic Documentation							X	X													X											
JSL II- PR Dives & Photography															X	-	-	X														
JSL I- Collection of Structural Test Samples																											X					
JSL I-- Profile Data Collection																						X										
Destaging																														XX	-	X

E. ENVIRONMENTAL CONDITIONS

The environmental conditions which will have a significant impact on the execution of the mission are:

Sea State - The R/V JOHNSON cannot operate in a sea state greater than 5 as it is unable to launch or recover the J-S-L. Therefore, any time such conditions arise the operation will be halted until calmer seas. The weather forecast will be monitored on Channel WX and contact will be made with the National Weather Service to inform it of the planned mission so it may provide up-to-date information upon request.

Currents - Because the operating propulsion of the J-S-L is 1.5 knots any bottom currents over 1.5 knots will require review of the planned dive.

Turbidity - Reduced visibility in the water could have an impact on the use of divers, the ability to obtain good photographic data and limit submersible operations.

F. ALTERNATE OBJECTIVES

The location of the test excavation site was selected based upon existing photographs of the wreck. Although the chances are good that the selected site will be acceptable, a final decision will not be made until an archaeologist has reconnoitered the area. If large objects not visible in the photographs obstruct the site and a substitute site is not located, test excavation may not be feasible during this mission. In the event that this occurs, the following alternate objectives will be undertaken as time permits:

1. Sample Recovery

To assist in the evaluation of the condition and structural integrity of the MONITOR, additional samples of the hull plating, the structural wood or a composite iron and wood artifact are required. In the case of hull plates, a sample will be selected from those not presently attached to the hull. Wood samples, on the other hand, will be removed from the armor belt, deck or deck beam locations and an effort will be made to sample wood exposed to seawater and that which has been isolated by sediment. Recovery of an artifact composed of iron and wood, if feasible, will provide an understanding of the general preservation of the vessel and the problems and costs associated with treating such an item after removal from the site. Recovery of all artifacts will be done by a diver using a cradle and lift bag system designed for this task.

2. Photographic Documentation

Areas of interest that scientists and engineers would like to study will be covered by both still photography and video tape recording.

3. Installation of Additional Control Datum Points

With existing equipment, additional control datum points can be installed on the wreck. If currents are favorable installation of the points can take place on the south side of the wreck.

No alternative mission plans are proposed during those environmental conditions as specified in Section IV(E).

IV. ORGANIZATION AND PERSONNEL

The flow chart shown in Figure 10 illustrates diagrammatically the organization of the participants in the operation.

A. CHAIN OF COMMAND AND RESPONSIBILITIES

Sanctuaries Program Office/Operations and Enforcement - Responsible for overall program planning and coordination. The safety of personnel and the integrity of the MONITOR will be foremost at all time, and he will be advised by those persons responsible for the safety and support of the open sea operation. He will be responsible for keeping the Assistant Administrator for Coastal Zone Management and Acting Director of Sanctuary Programs informed of all ongoing activities.

NOAA Representative - He is responsible for insuring that the project objectives are met and that the cultural integrity of the MONITOR is not compromised. He will keep the Operations and Enforcement Director of the Sanctuary Programs Office informed of any problems affecting the mission. He may, in the event it is necessary, and only under circumstances where he believes a threat exists to the structural integrity of the MONITOR or if a failure to observe pre-arranged operational plans, he will suspend further project operations.

Operations Director - He is responsible for the overall safe and efficient operation of the mission. Safety of the operation will be foremost in his mind, and he will keep the NOAA Representative advised of any event which could alter the mission's plan or affect the operating, tracking, and recovery of the unmanned vehicle and the submersibles. He will make the final decision as to the readiness of the submersible to operate. He will direct those personnel responsible to him in carrying out their assigned duties and assure that all diving equipment is functional and properly maintained.

Archaeological Advisor - He will offer recommendations as to the techniques required in accomplishing the project objectives. He will make the on site determination as to the location of the test excavation, the photography and the placement of the control datum points. While the Archaeological Advisor does not have line authority, or direct responsibility for the project it would be under unusual circumstances that adherance to his advise would be overridden.

Operations Manager - He is responsible to the Operations Director and can assume most of the responsibilities of the Operations Director. In the case of a dual simultaneous submersible operation the Operations Manager will be responsible for the coordination of launching, operating, tracking, and recovery of the second submersible.

Support Ship Captain - He is responsible for the safe operation of the support ship and its equipment and personnel. He will coordinate with the Operations Director all support ship activities with respect to submersible operations.

Unmanned Vehicle Operator - He is responsible for the overall safety of the unmanned vehicle operation. He will advise the Operations Director and the NOAA Representative of any event which could alter the mission's plan or affect the safety of the operation. He will advise the Operations Director as to the readiness of the unmanned vehicle to operate. He is responsible for training all personnel working on the unmanned vehicle operation with the use of the equipment and the procedures for conducting the planned diving mission.

Public Affairs Officer - Responsible for the overall coordination and flow of information to the general public concerning the mission plan and daily operations. Visits by the press and other visitors will be coordinated by the Public Affairs Officer with the Operations Director. NOAA's public affairs representative shall review and approve all NOAA press releases and the HBF representative shall be responsible for all HBF public affairs.

B. KEY PERSONNEL AND THEIR QUALIFICATIONS

Noted below.

C. PARTICIPANTS AND THEIR DUTIES

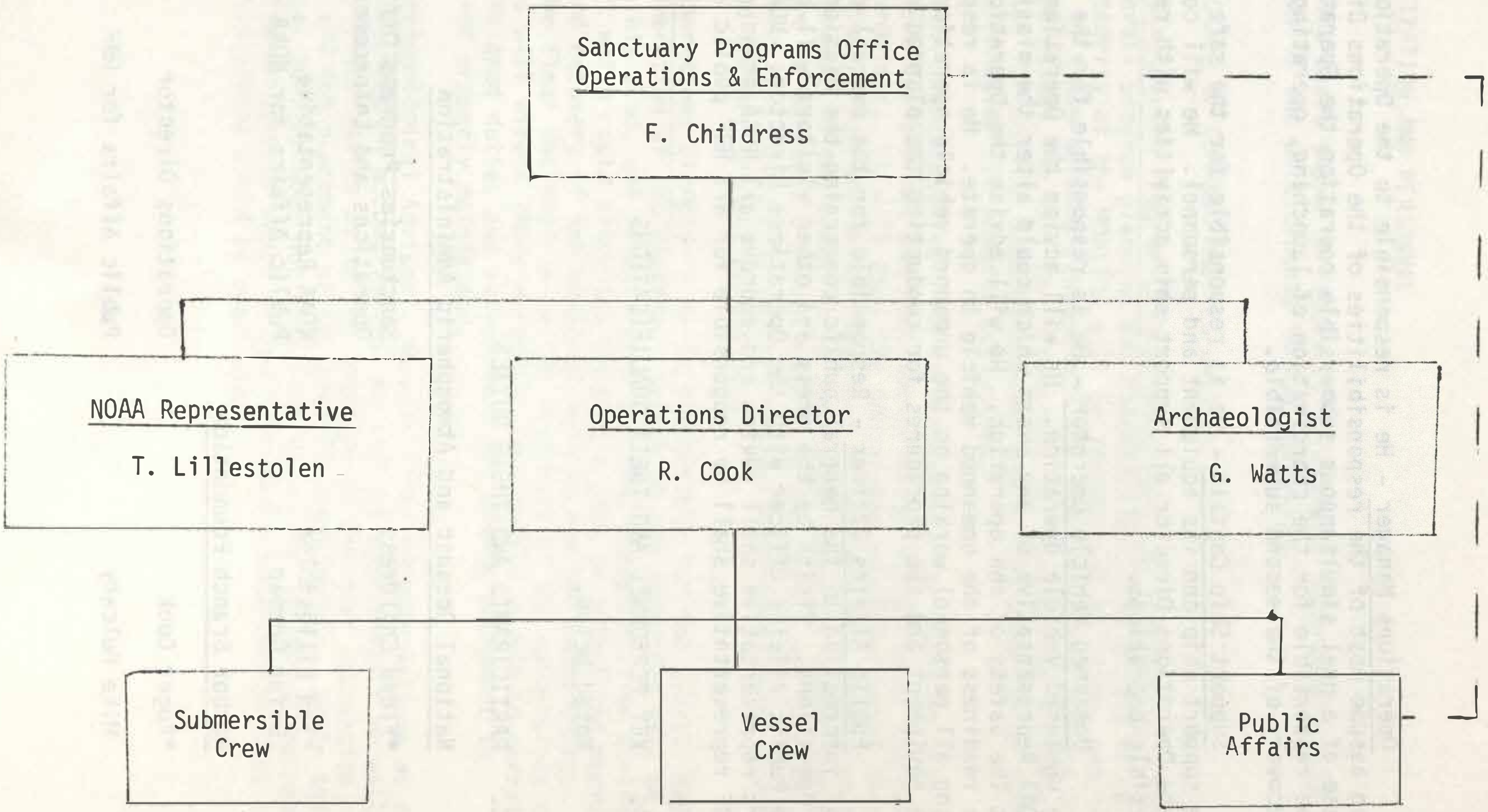
National Oceanic and Atmospheric Administration

*Floyd Childress	Sanctuaries Programs Office Operations and Enforcement
*Ted Lillestolen	NOAA Representative
Brian Gorman	Public Affairs for NOAA

Harbor Branch Foundation

*Roger Cook	Operations Director
Mike Mulcahy	Public Affairs for HBF

FIGURE 10



Sanctuary Programs Office
Operations & Enforcement
F. Childress
NOAA Representative
T. Lillestolen
Operations Director
R. Cook
Archaeologist
G. Watts
Submersible Crew
Vessel Crew
Public Affairs

R/V JOHNSON

Joseph Morgan	Captain
George Chapman	Mate
Edmond Warren	Engineer/Seaman
Harry Spaulding	Chief Engineer
Steve Cartwright	Steward
Rodney Coffman	Seaman

JOHNSON-SEA-LINK I & II

*Jeffrey Prentice	Operations Manager
Tim Askew	Submersible Pilot/Diver
Marshall Flake	Submersible Pilot/Diver
Mike Mitchell	Electronics Technician/Diver
Gene Melton	Submersible Pilot/Diver
George Hayes	Electronics Technician/Diver
Rich Roesch	Submersible Technician/Diver
Bill Bond	Submersible Technician/Diver
Rich Berg	Submersible Technician/Diver
Don Liberatore	Medical Technician

SEA GUARDIAN/CORD

*Chris Tietze	R & D Mechanical Engineer
Louis Blaisdeu	Unmanned Vehicles Operator

North Carolina Department of Cultural Resources

*Gordon Watts	Archaeological Advisor
*Richard Lawrence	Assistant Archaeological Advisor
*John Broadwater	Assistant Archaeological Advisor

*Indicates key personnel whose qualifications are included in Appendix 2.

V. FACILITIES AND EQUIPMENT TO BE USED

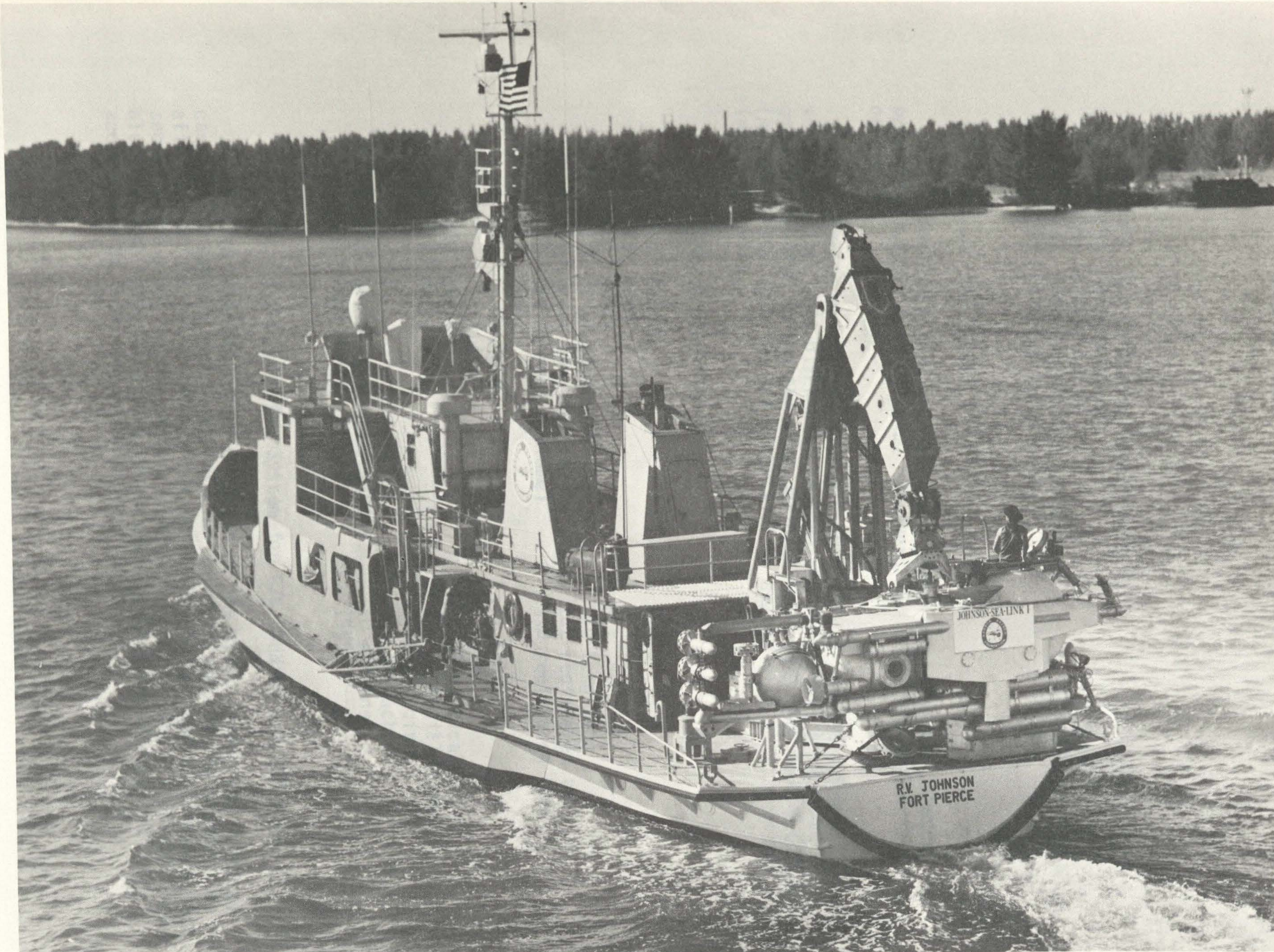
A. SURFACE SUPPORT SYSTEM DESCRIPTION

1. R/V JOHNSON

The R/V JOHNSON is a converted 125-foot Coast Guard Cutter. It was redesigned specifically to support the lock-out submersible, J-S-L, and is an integral part of a 1000-foot submersible lock-out system. The vessel provides a stable platform for the safe launch and retrieval of the submersible in seas up to State 5, a lock-on decompression facility, a scientific lab, and support facilities for 22 people.

a. General Specifications

(1)	Length, Overall	123'8"
(2)	Beam, Molded	26'8"
(3)	Displacement, Full Load	350 tons
(4)	Draft, Maximum	10'8"
(5)	Draft, Amidships Full Load	8'10"
(6)	Diesel Fuel	10,000 gallons
(7)	Potable Water	2,295 gallons
(8)	Dry Storage and Lockers	691 cu. ft.
(9)	Frozen Stores	53 cu. ft.
(10)	Berthing	18 berths
(11)	Galley Messing	6 seats
(12)	Lounge Messing	10 seats
(13)	Propulsion	2 - CAT 3408TA diesels, 400 BHP at 1800 RPM 365
(14)	Transmissions	MG514 (Omega) 4.5-1 Reduction Twin Disc
(15)	Bow Thruster	80 H.P. Schottel unit
(16)	Electrical Power	2 GM 471 diesels, 75 KW each
(17)	Distillers (2)	1 - Caterpillar 30 KW 208 VAC, Riley-Beaird, 400 gallons per day



JOHNSON-SEA-LINK I
R.V. JOHNSON
FORT PIERCE

(18)	Air Condition Compressors (2)	7 1/2 tons
(19)	Maximum Speed	14 knots
(20)	Cruise Speed	12 knots
(21)	Fuel Consumption at Cruise	34 gallons per hour
(22)	Foredeck Cargo Crane	4 tons

2. SEA DIVER

SEA DIVER serves in the same capacity as the R/V JOHNSON providing support to the J-S-L. However, SEA DIVER has no DDC facility on board.

During this expedition R/V JOHNSON will be the primary vessel on site. SEA DIVER will be involved in another project in the general vicinity during the same period. Four days have been scheduled (August 13-16) when the SEA DIVER will be at the site to accommodate visiting dignitaries.

a. General Specifications

(1)	Length	100'0"
(2)	Beam	22'0"
(3)	Draft	9'1"
(4)	Displacement (weight)	270 long tons
(5)	Gross Tonnage (volume)	162 registered tons
(6)	Net Tonnage (volume)	110 registered tons
(7)	Speed:	
	Maximum	11 knots
	Cruise	9 knots
(8)	Range	5,000 Nautical Miles
(9)	Propulsion	2 - Caterpillar model 3406TA engine 275 HP each
(10)	Berthing Accommodations	10 persons
(11)	Year Built	1959

3. J-S-L Handling System for R/V JOHNSON and SEA DIVER

The handling system consists of one hydro crane, two vertical capstans, a battery pod footprint, two vertical supports to support the after end of the J-S-L and various pad eyes, chains, and turnbuckles for securing the J-S-L to the deck. In addition to this the R/V JOHNSON has aluminum pipe back stops with gates that can be moved through 90° to accommodate an inner and outer tiedown position.


SEA DIVER

The hydro crane was designed principally for the launch and retrieval of the J-S-L over the stern of a small ship. It can be used for other purposes provided the design loads are not exceeded.

It is constructed entirely of aluminum alloy 6061-T6 welded with 5356 electrode and has a 100 percent hydraulically operated system. Incorporated in the crane head is a hydraulic braking system that dampens roll and pitch of the suspended load when it is in the housed position.

The R/V JOHNSON receives its hydraulic power for the submersible handling system from two Sunstran 55 G.P.M. pumps which are clutched to the frame of each main engine. The crane hydraulic power can be cross-connected with the forward hydraulic system which furnishes power to the bow thruster, anchor windless, and cargo crane.

a. Pertinent Data

(1) Crane Maximum Hydraulic Pressure - 2500 PSI
(2) Brake Maximum Hydraulic Pressure - 1000 PSI
(3) Cable type - 7/8" dia. 6 x 25 IWRC, extra improved plow steel, prestretched, right regular lay, bright finish, breaking strength 80,000 lbs.
(4) Average pick-up velocity - 1.4 ft. per second

b. Maximum Sea Condition

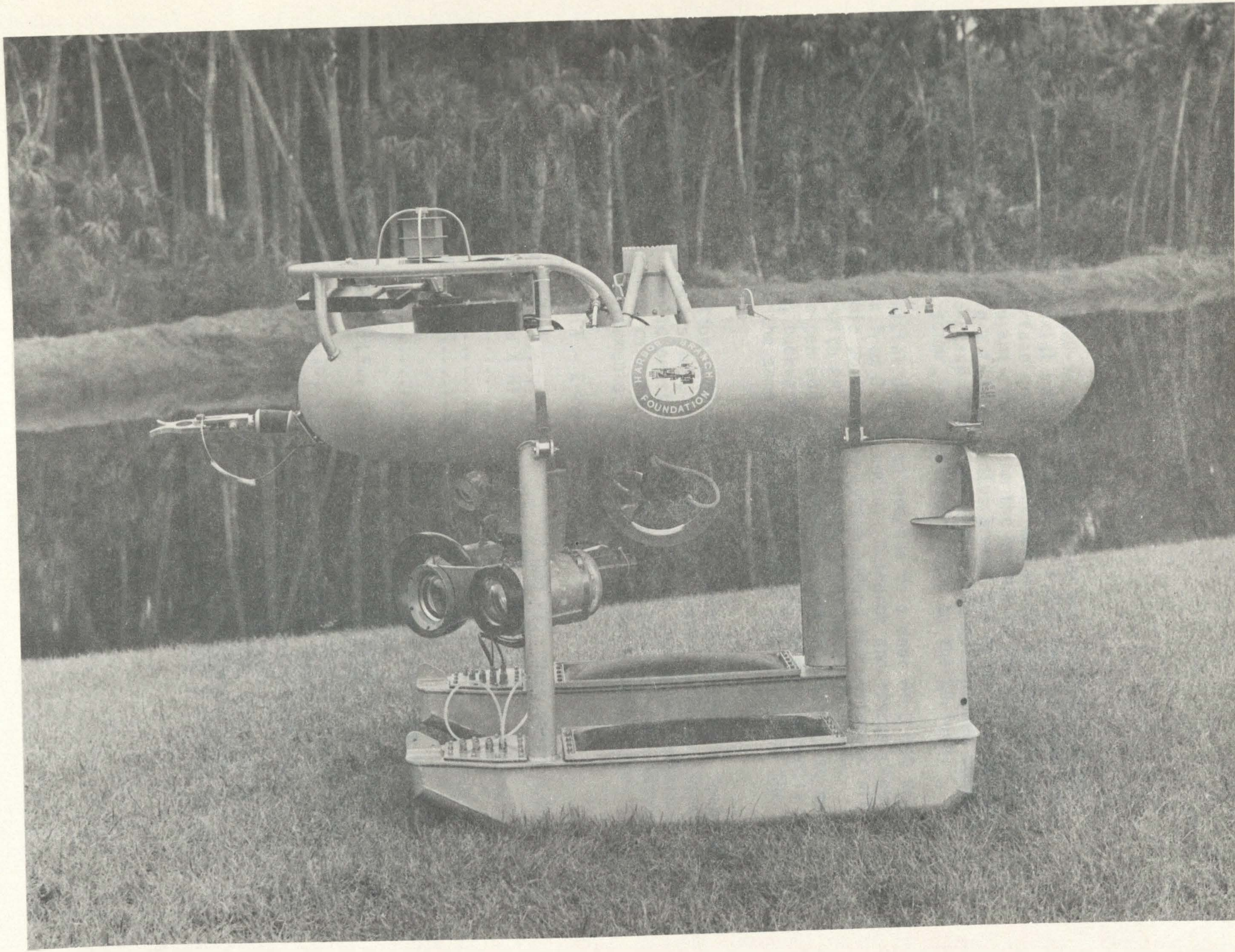
(1) Sea State 4 with 22,000 lbs. load
(2) Sea State 5 with 20,000 lbs. load
(3) Pitch ± 10° for 6 seconds
(4) Roll ± 10° for 8 seconds

B. UNMANNED SYSTEM DESCRIPTION

1. Cabled Observation and Rescue Device (CORD II), and SEA GUARDIAN

CORD II was conceived primarily to provide emergency assistance to small research submersibles. Of equal importance is its ability to perform scientific missions, providing another means of gathering knowledge of the ocean.

The CORD structure can be divided into two major portions: a "U" shaped ten-inch diameter tube provides not only flotation, but also pressure integrity for the bulk of the electronics, and a pair of "pods" providing a footprint and a pressure compensated hydraulic reservoir and protected mounting locations for electric and hydraulic components.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In Operation, CORD is tethered to a surface craft by a 0.35 - inch diameter armored coaxial cable. There are 1,850 feet of bare cable available between the surface and a current deflection weight, and one 100 feet of neutrally buoyant cable from the weight to the CORD, thus enabling CORD to swing in a 100-ft. radius around the deflection weight. The cable carries 5-KW 3-phase 60Hz power along with multiplexed command signals to CORD and TV, sonar, and instrument data to the surface.

CORD has an initial design to operate to a dept of 3,000 ft., through surface currents from 0 to 5 knots. Research and rescue capabilities include a dynamic positioning system aboard the surface craft, a high resolution sonar with PPI readout, low light level TV camera and light on a hydraulic pan and tilt mechanism, and the ability to move proportionally, forward, backward, up, down, rotate, or move directly sideways in response to the same manipulation of a "joy stick" on the control console topside.

Other information provided includes direction (magnetic compass), distance off bottom (acoustic), depth (pressure), water velocity, water temperature, and hydraulic pressure. CORD provides for add-on external equipment, two hydraulic circuits, two electrical circuits, five inputs for reading sensory instruments, and a limited pneumatic capability.

Specifications: (RCT - 2-22-79)

OPERATING DEPTH...........:	3,000 FT., test depth 3,500
DIMENSION (L X W X H)......:	60" x 43" x 49"
WEIGHT, DRY................:	910 LBS., with TV Camera
SPEED......................:	3 KTS., surface
STRUCTURE..................:	"U" Shaped Pressure Hull and pods
BUOYANCY...................:	"U" Shaped Pressure Hull, 200 LBS.
BUOYANCY, VARIABLE.........:	Oil Displacement, 10 LBS. @ 1,000 FT.
UMBILICAL..................:	Torque Balanced Armored 3/8" Coaxial Cable
CLUNK......................:	Current Deflection WT. 400-600 LBS.
TETHER.....................:	Clunk > CORD, 200' TRYAX, 3/4" Polypro - Line
POWER REQUIREMENTS.........:	5 KW 500 VAC 3 - PHASE 60 Hz

PROPULSION................:	4 Hydraulic, Proportional Thrusters, Fixed Propellers, 1.5 HP Each 2 FW, Aft; 1 Lateral; 1 Vertical, Bollard Thrust Per Unit, 90 LBS.

2. SEA GUARDIAN

The SEA GUARDIAN is a 27'4" aluminum utility-rescue launch, powered by a 116 HP diesel. The boat can be pinpointed over a location and remain there using bow and stern thrusters controlled by a dynamic positioning system. CORD II will be operated from the launch.

General Specifications: (RCT - 2-22-79)

Length	27'4"
Beam	9'4"
Draft	3'1"
Speed	8 knots
Range	100 Nautical Miles
Weight	13,000 lbs.
Special Characteristics	Mother Vessel for OCRD Control and Position Monitoring for CORD CORD T.V. Display CORD Precision Scanning Sonar Display Dynamic Positioning System

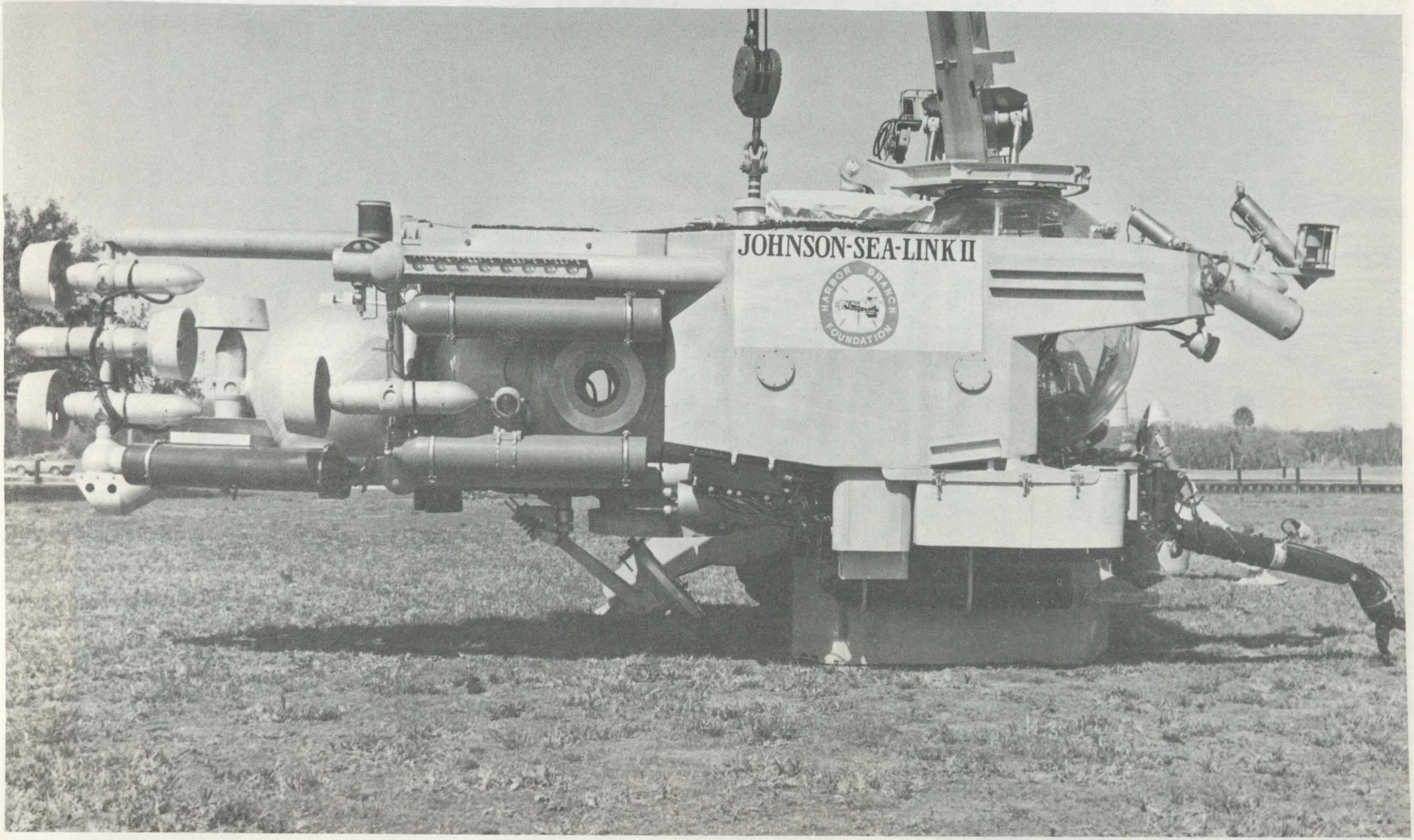
C. MANNED UNDERSEA SYSTEM DESCRIPTION

JOHNSON-SEA-LINK I and II (J-S-L)

J-S-L I and II will be used during the mission. The description and specifications discussed below apply to both submersibles.

1. General Description

The J-S-L is a small research submarine designed to operate at depths to 3,000 feet. The J-S-L has two manned pressure hulls: a two-man sphere constructed of four-inch thick plexiglass and a separate dive compartment made of welded aluminum. The sphere provides the pilot and one observer with panoramic visibility and is maintained at one atmosphere. The diver compartment has two view ports for scientific


JOHNSON-SEA-LINK II
HARBOR BRANCH FOUNDATION

observation at one atmosphere and is designed for a diver lock-out to 1,500 feet and mating to a deck decompression facility. The frame, ballast tanks, and electrical/electronic housing are all constructed from aluminum. It is equipped with SONAR, underwater communication, FM transceiver for surface communication, intercom, Doppler navigation system, echo sounder, mechanical arm, life support systems, and closed circuit diving equipment. Eight thrusters provide three dimensional mobility. A battery compensated with oil provides DC power and a static inverter converts DC to AC.

2. General Specifications

a. Classified by - American Bureau of Shipping

b. Dimensions

(1) Overall

(a)	Length	22'10.25"
(b)	Beam	7'10.75"
(c)	Height	10'7"
(d)	Draft	7'6"
(e)	Weight	21,481 lbs.
(f)	Payload	1,335 lbs.
(g)	Gross Weight	22,816 lbs.

(2) Pilot's Sphere

(a)	Inside Diameter	58"
(b)	Hull Thickness	4"
(c)	Internal Volume	59 cu. ft.
(d)	Hatch Opening	18" diameter
(e)	External Pressure	

1.	Operating Depth	3,000'
2.	Classification Depth	1,000'
3.	Test Depth	2,300'
4.	Crush Depth	8,000'

Description

The sphere contains the following: sphere electrical control panel, sphere junction box, electronic equipment rack, Straza sonar electronics, Straza underwater telephone electronics, Sperry Doppler Navigator, Magnesyn compass, echo-sounder, one FM transceiver, underwater loudspeaker amplifier, diver's communications amplifier, sound powered phone, thruster control unit freon detector, PO2 and PCO2 analyzers, diver compartment PO2 and PCO2 monitors, two CO2 scrubbers, air conditioning coil and fans, mechanical arm control unit, two seats, two oxygen regulators, oxygen flow meter, low pressure air regulator, two emergency breathing regulators, two face masks, high pressure air manifold, high pressure gas manifold, variable ballast flood valves, diver's bilge flood and exhaust valves, battery drop mechanism, two inflatable vests, tool kit, spare fuses, first aid kit, two saltwater desalter kits, fifty pounds of spare LiOH, two flashlights, external pressure gauge, internal pressure gauge, diver compartment pressure gauge, fire extinguisher, flares and potable water.

The sphere is manned by a J-S-L pilot and one observer who has been briefed on the sphere or is a J-S-L crew member. The sphere is always maintained at one atmosphere but is capable of withstanding 60 psi over external pressure. Decompression of the diver compartment is normally controlled from the sphere.

(3) Diver Compartment

(a)	Length	8'
(b)	Internal Diameter	52.78"
(c)	Hull Thickness	
	1. Side Wall	3.36"
	2. Heads	2.33" - 2.80"
(d)	Internal Volume	73 cu. ft.
(e)	Medical Lock	4" I.D. x 11.5" deep
(f)	Side Ports	10" dia. x 4" thick
(g)	"A" Hatch Port	7" dia. x 2" thick
(h)	"B" Hatch Opening	7" dia. x 2" thick
(i)	"A" Hatch Opening	27" diameter
(j)	"B" Hatch Opening	24" diameter
(k)	Manway Opening	20" diameter

(l) External Pressure

1. Operating Depth 3,000'
2. Classification Depth 1,000'
3. Test Depth 4,500'
4. Crush Depth 6,000'

(m) Internal Pressure

1. Test Pressure 1,000 psi
2. Operating Pressure 670 psi

Description

The diver compartment is a welded aluminum cylinder with spherical heads. It has a medical lock, a front and two side view ports as well as a viewpoint in "A" hatch, two penetrator plugs, a bilge under a plexiglass floor that serves as a ballast tank, and a manway with an internal hatch that seats with internal pressure and an external hatch that seats with sea water pressure. The entrance to the manway is a 32 inch-bolt circle flange used to mate the submersible to a decompression facility. The diver compartment contains the following: an electrical junction box, CO_2 scrubber, two oxygen masks with overboard dump, one Bio-Marine closed cycle rebreathers, or appropriate diver breathing apparatus, two emergency breathing regulators, two umbilicals, one fan, one overhead light, one diver's light, one H.P. gas manifold and regulator, one oxygen manifold, two bilge ballast valves, one O_2 analyzer, two CO_2 analyzers, one spare "A" hatch "O" ring, one spare "B" hatch "O" ring and seating ring, two face masks, two diver's knives, two sets of swim fins, two inflatable vests, one tool kit, one first aid kit, two-and-one-half gallons of potable water, protective clothing, 50 pounds of spare LiOH, "B" hatch dogging wrench, one fire extinguisher, overhead rigging gear, dive tables, morse code, O_2 flow meter, external pressure gauge, internal pressure gauge, sound powered phone, one intercom speaker and headset, spare light bulb, emergency main ballast blow system, and medical lock.

The tender compartment is always manned by one J-S-L diver and one observer who has been briefed on the diver compartment systems or another J-S-L diver in the case of a planned lock-out dive. It is maintained at one atmosphere except when preparing for a lock-out. "A" hatch has a view port observing obstruction on the bottom that might impede lock-out. A front view port is provided for viewing between the sphere and diver compartment and two side viewports are provided for lateral visibility. The diver compartment is always equipped for a

c. Construction Materials

(1) Pilot's Sphere	Acrylic Plexiglass
(2) Diver Compartment	Aluminum 5456
(3) Frame	Aluminum 6061

d. Air Supply

(1) Air

(a) Four Steel "T" Cylinders (J-S-L II)

1. Maximum Pressure	2400 psi
Volume at 2640 psi	327 cu. ft. ea

Description

Air is stored in two separate banks of two cylinders each. The air cylinders are attached to the submersible's lower frame on the port and starboard sides of the battery pod. Both banks are piped into the pilot's sphere and teed together. Either or both banks may be selected to supply air to the pilot's sphere H.P. air manifold. The H.P. air manifold can be supplied from the pilot's sphere H.P. gas manifold.

(2) Oxygen

(a) Two Steel "T" Cylinders (J-S-L II)

1. Maximum Pressure	2400 psi
Volume at 2640 psi	330 cu. ft. ea.

Description

Oxygen is stored in two separate cylinders. The oxygen cylinders are attached to the submersible's lower frame on the port and starboard sides aft of the diver compartment. Both cylinders are tied together after being piped into the pilot's sphere. This system supplies oxygen to regulator, regulator by-pass, sphere flow meter, to the diver compartment depth guage/coupling line valve which provides an alternate means of supplying oxygen to the diver compartment, diver compartment oxygen regulator, and regulator by-pass. Both oxygen cylinders can be charged with a common fill connection.

High pressure oxygen is piped from the pilot's sphere into the diver compartment oxygen manifold where it is regulated to low pressure supplying the diver compartment flow meter, oxygen flow meter by-pass valve, and two oxygen masks that are equipped with overboard dump. High pressure oxygen is piped to the closed circuit rebreather.

(4) Gas

(a) One Aluminum Sphere

1.	Maximum Pressure	1900 psi
2.	Volume at 1900 psi	1769 cu. ft.

(b) Five Steel "T" Cylinders (J-S-L II)

1.	Maximum Pressure	2400 psi
2.	Volume at 2400 psi	309 cu. ft. ea.

Description

The gas sphere in J-S-L II is located aft of the after "A" frame between the lower frame and the strong-back. Gas is piped from the gas sphere into the pilot's sphere H.P. gas manifold. The H.P. gas manifold supplied the pilot's sphere pressurization valve, the diver compartment pressurization valve, and the diver's gas supply valve.

High pressure gas from the pilot's sphere diver's gas supply valve is piped into the diver compartment H.P. gas manifold and supplies the diver compartment blow down valve, emergency main ballast tank blow valve, L.P. regulator and by-pass valve. The L.P. regulator supplies gas to the breathing gas manifold for hookah and emergency breathing regulators.

e. Ballast Capacities

(1)	Main Ballast Tanks	3455 lbs. S.W.
(2)	Variable Ballast Tanks	352 lbs. S.W.
(3)	Dive Ballast Tanks	402 lbs. S.W.
(4)	Diver Compartment Bilge Tanks	286 lbs. S.W.

f. Power

(1) Battery

(a) Fourteen, 2 VDC EXIDE DTG-33 Lead-acid Batteries
(b) 1152 Ampere-hours
(c) Oil Compensated (25 gal. mineral oil)

Description

The battery is built from fourteen 2-VDC lead-acid batteries wired in series and center tapped to provide ± 14 VDC and DC common. The batteries are housed inside an aluminum pod with a plexiglass top and is attached to the bottom of the submersible frame under the sphere. The pod is filled with mineral oil and pressure compensated through 1/2 inch lines from two oil filled bladders housed in a compartment on the front, front of the battery pod. The plexiglass top contains an oil filling port, vent valve set for approximately .25 lbs., a four conductor penetrator to connect the water detection and battery shunt circuit to the pilot's sphere. Two single conductor penetrators for battery charging, and two battery posts. When the battery is fully charged it will indicate 31 VDC, and when it is about depleted it will indicate approximately 24.5 VDC.

(2) Static Inverter

(a) Input

1. Voltage 24 to 32 VDC
2. Current 4 to 16 amp.

(b) Output

1. Voltage 115 VRMS ± 5%
2. Power 0 to 250 VA
3. Frequency 60 Hz ± .6 Hz

Description

The DC to AC inverter is mounted in a pressure proof cylinder attached to the frame of the submersible under the after end of the port main ballast tank. The inverter is energized by closing a switch on the sphere electrical control panel. The AC is routed into the sphere junction box and then out to the sonar and one outlet on the sphere electrical control panel.

g. Propulsion

(1) Eight Indentical Thrusters

(a) Propeller - Four Blades 14 x 14 L.H.
(b) Motor

1. Permanent Magnet Continuous Duty
2. Reversible
3. 1.25 H.P. at 3900 RPM
4. 28 VDC

(c) Planetary Reduction Gears 9 - 1

(d) Thrust 100 lbs. ea.

Description

The J-S-L obtains its three dimensional mobility from eight thruster units. All thrusters are controlled by individual switches on the thruster control unit inside the pilot's sphere.

h. Life Support

(1) Endurance 480 man hours (20 man days)
(2) Carbon Dioxide Scrubbers

(a) Diver Compartment Lindbergh-Hammer #787M9/H.B.F. Mod.

(b) Pilot's Sphere Harbor Branch Foundation, Inc., Scrubber

Description

The dive chamber scrubber is a metal container consisting of a sealed continuous duty motor that is magnetically coupled to dual turbines and a refillable scrubber canister. It is mounted in the after end of the diver compartment and power is applied by closing a switch on the sphere's electrical control panel.

The HBF scrubber is a round container consisting of two boxer fans bolted in series, a refillable scrubber canister and a filter. It is mounted under the sphere hatch and power is applied by closing a switch on the sphere's electrical control panel.

The units are cycled on and off as necessary to keep the CO2 level within normal limits. Fifty pounds of spare LiOH are carried in both the sphere and diver compartment, for refilling the canister, and yields 480 additional man hours of scrubbing ability.

(3) Bio-Marine CCR-1000

(a) Operational Duration	6 hours per scrubber charged

Description

As a life support system, the Bio-Marine CCR-1000 can be used in the closed cycle diving mode or the units can be used to scrub the CO2 from the atmosphere. The unit can be used as a scrubber by disconnecting the exhaust side of the breathing hose and breathing normally through the mouthpiece. Gas supply and electrical power is secured.

(4) Emergency Breathing Regulators

(a) Pilot's Sphere	2

Description

Emergency breathing regulators are provided in the pilot's sphere. Air or gas may be selected as a breathing medium. In case of fire, flooding, or atmosphere contamination emergency breathing regulators will be donned.

(5) Oxygen Masks

(a) Diver Compartment	2

Oxygen masks with overboard dump are provided in the diver compartment.

(6) Oxygen Analyzer

(a) Pilot's Sphere

1. One Beckman Atmospheric Oxygen Model (AOM)6602

Description

A portable Beckman AOM 6602 is calibrated in the pilot's sphere during the pre-launch check before each mission.

2. One Remote Meter AOM 6602 from Diver Compartment

(b) Diver Compartment - One Beckman Minos Atmospheric Oxygen Monitor Model AOM 6602

Description

During the pre-launch check before each mission a bulkhead mounted Beckman Minos AOM 6602 is calibrated and clamped to a frame in front of the diver compartment. It is removed during the post dive check after each mission. A remote monitor is permanently installed in the pilot's sphere. Either external or internal power may be selected on the diver compartment AOM 6602. The sensor is insensitive to other gases, and the output current is directly proportional to the partial pressure of oxygen.

(8) Carbon Dioxide Monitors

(a) Pilot's Sphere

1. One Beckman Minos Atmospheric Carbon Dioxide Monitor (ACDM)
2. One Bendix Gastec Analyzer - hand pump type
3. One Remote ACDM Meter Monitor from Diver Compartment

(b) Diver Compartment

1. One Beckman Minos ADCM
2. One Bendix Gastec Analyzer - hand pump type

i. Operating Characteristics

(1) Depth	0-1000'
(2) Speed	
(a) Cruise	.75 knots 2 motors
(b) Maximum	1.5 knots 4 motors

D. DIVER DESCRIPTION AND EQUIPMENT

1. JOHNSON-SEA-LINK Lock-out Dives

a. Breathing Equipment

Primary	Umbilical-supplied open circuit KMB-10 hat with communications (3000 cu. ft. of gas available)
Secondary	Small Auxiliary Bail-out Bottle (18 cu. ft.) (KMB-10 only)
b. Breathing Mixture	Mixed Gas (10% O2, 90% HE)

Description

Normally a lock-out dive from the J-S-L- will consist of one tethered diver who is tended by another diver from inside the dive compartment.

As the J-S-L approaches a lock-out site, the pilot passes the word to the divers to prepare for a lock-out.

When the J-S-L arrives at the lock-out site, the pilot positions the J-S-L on the bottom, pointing into the current at the work site, reports his depth to the support ship and requests permission to flood down.

After the divers are dressed out and report ready for lock-out, the pilot requests permission from the surface to blow down, The divers secure their O2 bleed and CO2 scrubber, check "A" hatch undogged and report to the pilot standing by for blow down. Then the pilot initiates a count down over the underwater telephone and the J-S-L intercom. The diver-tender controls blow down in the diver compartment and maintains a 100' per minute descent rate. The rate of descent is monitored by the pilot. (If necessary, the pilot can override the tender.) When the diver compartment equalizes and the "A" hatch seal is broken, the pilot reports to the support ship.

When the "A" hatch seal is broken, the diver-tender secures the blow down, pushes "A" hatch clear of the manway and gives the diver a last minute check before he enters the water.

When the diver initially enters the water, he gives the J-S-L a lift test by trying to lift it off the bottom, and makes a communication check with the pilot before leaving the diver compartment.

The pilot reports to the support ship that the diver is out. The diver is continuously monitored by the pilot and observer throughout the dive. The diver's bottom time is kept by the diver-tender, pilot, and support ship. The diver's umbilical is tended throughout the dive by the diver-tender.

When the diver returns to the J-S-L at the completion of his task, the diver-tender takes up the umbilical and assists the diver through the manway, lifts and dogs "A" hatch, drops "B" hatch and over pressurizes the diver compartment 5'-10'. The pilot reports the over-pressurization depth in the diver compartment to the support ship and requests permission to surface.

The divers blow the bilge ballast tanks and the pilot commences blowing the diver ballast tanks. The pilot reports to the support ship when the ballast tanks are blown dry.

As the J-S-L leaves the bottom, the divers commence venting the diver compartment to their first stop. The venting is monitored by the pilot and observer. Venting can be controlled either from the pilot's sphere or the diver compartment.

2. Surface Support

a. Communications will be maintained between divers and pilot during swimming excursions, via hard wire.

b. Communications will be maintained during lock-out dives from diver to submersible to R/V JOHNSON.

c. Should prolonged decompression or treatment be necessary following a lock-out excursion, the submersible will return to the surface and be mated to the decompression chamber aboard R/V JOHNSON.

d. All diving will be via diver lock-out.

3. Decompression Schedule

During 1975 HBF found it necessary to obtain reliable and well tested helium/oxygen decompression tables to depths of 400 feet. After reviewing various tables it was found that the Oceaneering tables far surpassed HBF's criteria. These tables along with other tables were submitted to the Duke Hyperbaric facility and were thoroughly evaluated by computer methods. After the evaluation Duke confirmed that the Oceaneering table "E" was in fact safer than other tables available. At that time Oceaneering had over 90 dives using the "E" table with no symptoms of decompression sickness. Since then HBF has conducted 75 dives on helium/oxygen mixtures using Oceaneering table "E".

Mandatory features of the Oceaneering table "E" are the following: 1) Blow down on a 90 percent Helium/10 percent Oxygen mixture at the rate not to exceed 100 feet per minute. 2) Travel rates to the first stop during ascent varies as per the time and depth of the dive. 3) Air flush begins at 180 feet and divers breathe pure air at a depth of 140 feet travel time between stops is at the rate of 10 feet per minute and this time is included in the next stop. 5) Travel time from the last stop to the surface is always 12 minutes regardless of the depth of the last stop. 6) 02 masks are to be removed during the last ascent to the surface.

a. General Description

The characteristics of helium-oxygen decompression are different from those of air. With the latter a larger volume of gas is concentrated in the faster saturating parts of the body, and the rapid diffusion of gas from one part of the body to another on reduction of pressure requires keeping the body at high pressures for a longer time during the primary period of decompression. In helium diving the rate of absorption of gas by body tissues and its elimination is more rapid, hence the actual tissue saturation content contains less gas than a dive involving nitrogen. For instance, the watery tissues, such as blood or lean muscle, will hold about 1 1/2 times more nitrogen than helium. In addition, the proportions of gas held by the different types of body tissues vary between gases. Thus, tissues that are high in fat content, such as fat, bone marrow, and spinal cord substance, will absorb more than five times as much nitrogen as will the watery tissues. For helium the proportion of gas held by these respective tissues is only about 1.7 to 1. As the rate of absorption for helium is more rapid than that of nitrogen, some tissues will take up more helium during a short exposure at a given depth. However, on decompression, the rate of elimination of helium from these tissues will also be more rapid than that of nitrogen. Cavitation, the formation of bubbles, can occur during decompression following both air and helium dives. Since helium is eliminated rapidly because of its lower solubility, more molecules of the gas become available earlier to form bubbles. Hence, the first decompression stop must be deeper in helium dives than in air dives. Accordingly, it is desired to emphasize that a diver can contract bends when using helium-oxygen mixtures as well as with normal air and that decompression in accordance with the table is essential. There are, however, some differences.

(1) Combined/Repetitive Dives

These are not permitted. A diver who has used helium as a breathing medium is not to dive again for a clear 24 hours after his decompression completion.

(2) Mandatory Feature

The mandatory feature of this Table is the switching to air at 140 feet irrespective of what depth the first stop may be at.

(3) Surface Interval

As combined/repetitive dives are not permitted there is no credit for surface interval between dives, though the term is used in surface oriented helium dives to describe the period between a diver leaving his last water stop, surfacing and being recompressed in a D.D.C. to a chamber depth. This surface interval must not exceed 5 minutes.

(4) Limiting Line

Limiting Lines appear on Table E as in Air Diving, i.e., that part of each depth section above the Limiting Line is the ordinary working table where the risk of decompression sickness is slight. Diving below the Limiting Line carries a greater risk of decompression sickness and increases in direct proportion to the duration below the line.

Decompression Schedule*
Blow Down Gas - 90% He/ 10% O_2

*Oceaneering Table H

Bottom Time	Time to First Stop	DECOMPRESSION STOPS: Breathing Air 170	160	150	140	130	120	110	100	90	80	70	60	50 O_2	40 air	40 O_2	30 air	30 O_2	30 air	30 O_2
DEPTH - 200 feet																				
10	3											1	2	4		13				
20	3									1	3	3	5	8		31				
30	3								2	3	5	6	8	10		40	10	20		
40	2							1	4	5	7	8	10	12		40	20	40		
50	2							4	6	7	8	11	13	14		40	20	50		
60	2						1	6	7	8	10	12	16	16	10	40	20	30	10	30
70	2						3	7	8	9	11	14	18	18	10	40	20	30	10	35
80	2					1	7	8	9	11	14	17	24	20	10	40	20	50	20	50
DEPTH - 210 feet																				
10	3										1	1	2	4		15				
20	3								1	2	2	4	6	8		35				
30	3							1	3	4	5	7	8	10		10	10	25		
40	3							3	5	6	7	8	11	12		40	10	35		
50	2						3	5	6	8	8	11	14	14		40	20	50		
60	2						5	6	7	9	10	13	18	16	10	40	20	30	10	30
70	2					3	6	8	8	10	12	16	20	18	10	40	20	30	10	40
80	2					6	7	8	10	12	15	19	24	22	10	40	20	60	20	60

Figure 2
(continued)

*Oceaneering Table E

Bottom Time	Time to First Stop	Breathing Air 170	160	150	140	130	120	110	100	90	80	70	60	50 O_2	40 air	40 O_2	30 air	30 O_2	30 air	30 O_2
DEPTH - 220 feet																				
10	3										1	1	3	6		15				
20	3								2	2	3	4	6	8		39				
30	3							2	3	5	5	7	9	10		40	10	30		
40	3						2	4	5	6	8	8	12	12		40	20	40		
50	2					1	5	5	7	8	9	11	15	16		40	20	50		
60	2					3	6	6	8	9	11	14	18	18	10	40	20	30	10	30
70	2				1	6	7	8	9	10	14	17	22	20	10	40	20	40	20	40
DEPTH - 230 feet																				
10	3									1	1	1	3	6		17				
20	3							1	2	2	4	5	6	8		43				
30	3						1	3	4	5	6	7	10	10		40	10	35		
40	3					1	3	4	6	7	8	9	12	12		40	20	45		
50	3					4	5	6	7	8	10	12	16	16	10	40	20	55		
60	2	Limiting			2	5	6	7	8	9	12	15	19	18	10	40	20	35	10	30
....		Line																		
70	2				4	6	8	8	9	12	14	18	23	20	10	40	20	40	20	50

(continued)

*Oceaneering Table B

Bottom Time	Time to First Stop	170	160	150	140	130	120	110	100	90	80	70	60	50 O_2	40 air	40 O_2	30 air	30 O_2	30 air	30 O_2
		DECOMPRESSION STOPS																		
		Breathing Air																		
DEPTH-240 feet																				
10	4									1	1	2	3	6		18				
20	3							2	2	3	3	6	6	8		47				
30	3						3	3	4	5	7	8	9	12		40	10	35		
40	3					3	4	4	6	7	8	10	13	14		40	20	45		
50	3				2	5	5	7	7	9	10	13	17	16	10	40	20	30	10	30
60	3				5	5	7	7	8	10	12	17	19	20	10	40	20	30	20	40
Limiting Line																				
70	2			3	6	7	7	8	9	13	15	19	24	22	10	40	20	50	20	50
DEPTH-250 feet																				
10	4								1	1	1	2	3	6		20				
20	3						1	2	2	3	5	5	7	10		50				
30	3					2	2	4	4	6	7	8	10	12		40	10	35		
40	3				1	4	4	5	6	8	8	11	13	14		40	20	50		
50	3			1	4	5	6	7	7	9	11	14	18	18	10	40	20	30	10	35
60	3			3	5	6	6	8	9	10	14	17	20	20	10	40	20	40	20	40
Limiting Line																				
70	2		2	6	6	7	8	9	11	14	16	22	25	24	10	40	20	50	20	60

b. Methods of Decompression

(1) In Table E, calculations have been based on a standard Divcon gas mixture of 90% helium and 10% oxygen, whether it be used as a "free-flow" or semi-closed circuit apparatus. Where a mixture is richer in oxygen than 10% i.e. the oxygen percentage is greater, this Table can be used with complete safety. Should an oxygen percentage of less than this be used, then separate tables will be provided.

(2) The methods of decompression available are:

Table	Range	Method
E	180-400 ft.	S.W.C. dives where T.U.P. can be effected. (N.B. Where T.U.P. cannot be done Table D is to be used)

E. PHOTOGRAPHIC EQUIPMENT

1. Camera Strobe

Hydroproducts Underwater Electronic Strobe Model PF-730.

a. Specifications:

(1) Pressure Proof Cylinder	7.75" dia. x 13"
(2) Test Depth	20,000 FSW
(3) 200 watt second flash	-
(4) Power	24-30 VDC
(5) Charging time at 9 amps is 6 seconds	
(6) Weight	
(a) In air	24 lbs.
(b) In sea water	8 lbs.

Description

The Hydroproducts PF-730 Sea Strobe is clamped on top of the forward starboard diver ballast tube and is moveable for adjusting flash coverage. The power cable plugs into the #1 E.O junction block on the lower frame starboard side under the sphere, for power and flash synchronization. Power is applied to the strobe by closing a switch on the electrical control panel. A standard flash photo contact cord is provided in the sphere for triggering the flash. Exposure is set by following a distance-aperature and visibility chart.

3. Deep Sea Camera

Edgerton Deep-Sea Standard Camera, Benthos Model No 372

a. Specifications:

(1) Film Capacity	750 exposures on 30-meter (100-foot) spools of 35 mm film
(2) Objective Lens Focal Length	(a) 35 mm in water; (b) 28 mm in air
(3) Objective Lens Aperture	Adjustable from f 3.5
(4) Objective Lens Focus	f22

Adjustable focus for distance in water from 0.6 meters to infinity. The focus scale is calibrated in both meters and feet underwater. The depth of field is automatically shown depending upon distance and aperture settings.

(5) Data Lens

Aperture adjustable from f2.S to f22. Fixed Focus

(6) Shutter

Electrically operated and controlled from a remote source of 28 volts D.C. power. Speed set at 1/20 second (50 ms). Adjustable from 1/25 (40 ms) to 2/5 second (400 ms).

(7) Viewing Angle	4° x 54°

(8) Alignment

Pin on Camera chassis positively aligns chassis with respect to the housing. Four orientations (90° apart) are possible.

(9) Rated Depth	12,000 meters
(10) Temperature Rating	-2°C to°C (28°F to 120°F)
(11) Capacitance	6000 mfd; 2 watt-seconds when charged to 28 volts D.C.
(12) Voltage	28 VDC

(13)	Current	0.7 amperes peak during film advance
(14)	Fuses	1 ampere, Slo-Blo
(15)	Connector	Amphenol 14-pin

(16) Data Chamber Actuation

Internal batteries (2 1.5 V Alkaline "C" Cell). Eveready E93 or equivalent.

(17) Camera Cycling Rate

Advance cycle completed in less than 3 seconds.

(18) Materials

(a)	Housing	17-4PH Stainless Steel
(b)	Window Retainer	303 Stainless Steel

(19) Weight

(a)	In air	48 lbs.
(b)	In seawater	35 lbs.

(20) Dimensions 4.842" dia. x 25.281"

4. Deep Sea Flash

Edgerton Deep-Sea Standard Flash, Benthos Model No. 382

a. Specifications:

(1) Depth Rating 12,000 meters

(2) Power Source

Benthos Model 389 Pack mounted within Flash housing. 28 VDC nickel-cadmium rechargerable type (24 Gould 1.2 volt, No. 4-OSCL, connected in series)

(3)	Capacitance	262 microfarads; 800 volts; 100 watt-seconds
(4)	Number of Flashes	Approximately 1,000 with fresh battery
(5)	Flash Duration	Approximately 1 milli-second
(6)	Recycle Time	3 seconds with full charges battery

(7) Spectrum of Light Output
White - Essentially the same spectrum as sunlight

(8) External Materials - Housing
Hardened 17-4PH stainless steel. Lamp Cover Annealed glass. Lamp Cover Retainer: PVX plastic.

(9) Weight

(a)	In air	63 lbs.
(b)	In seawater	50 lbs.

(10) Dimensions 8.25" dia. x 35.625"

F. EMERGENCY EQUIPMENT DESCRIPTION

See Appendix 3.

G. COMMUNICATIONS

1. Ship-to-Shore and Ship-to-Ship

Ship-to-Shore communication will be accomplished by SSB or VHF. The local shore base will be in Hatteras, North Carolina. There will also be communication with Link Port, Florida via SSB every morning at 0900, and more often if necessary. Ship-to-Ship will be via channel 16 and 80A.

2. Surface Unit Communications

Surface unit communications will be conducted via channel 16 between all surface vessels. Communication to the J-S-L will be via Sub Base VHF 153.260 and 158.280 MHz.

No interference as a result of other radio operators in the area is anticipated as the Coast Guard will patrol the MONITOR site to assure other vessels comply with the Marine Sanctuary Rules and Regulations.

3. Support to Undersea Platform

Underwater communications (UQC) sound frequency will be used.

4. Diver Communications

The lock-out diver will be able to communicate with the submersible pilot via open circuit, hard wire communication.

5. Communications and Sounding Equipment

a. Radio - (1) VHF - Modar Triton (M) 25W

12-channel, (2) SSB-Northern N-550 150W
12-channel, and (1) DSB/AM radiophone Konel
KR-132CA 135W - 8 channel

b. Echo Sounders (1) EDO Western 9057

1 - 6000 fathoms and (1) Furuno 1 - 2000 feet

c. Underwater Telephone - (1) Straza ATM 504-14

d. Passive Tracking Sonar - (1) Straza Model 9010

6. Radio Frequencies

R/V JOHNSON Fla. # FL 8402 BP	Expires 10/7/81 WYG 9140 (HB-402 VHF Modar (13 Monitor)
	Channels WX2-6-12-13-14-22-26-27-28-68-80A
	Sub Frequency
	Sub Crew Channels WYG 9140 (HB249)
	16 - Sub Freq. - 80A

S.S.B.#1	2082.5	4090.9	2182.0	2638.0
	2096.5	4385.3	-	2670.0
	4489.9	18590.2	4143.6	8291.0
	2031.5	-	-	-
	12345.2	12429.2	8207.4	8198.0
	13116.3	12432.2	8731.2	8722.0
	-	-	-	-
	8291.1			

S.S.B.#2	4143.6	W00410	16590.2	WOM 1206
	-		-	-
	W001203	12429.2	W00808	WOM 805
SEA DIVER Fla. # FL9337CA	Expires 7-31-79 WYR 2452 HB Modar VHF			
	Channels WX1-WX2-6-12-13-22A-25-26-27			
	68-72-80A			
	C.B. Ch. 1 thru 23 and P.A.			
S.S.B.#1	2082.2	2182	2031.5T	4143.6
	2096.5	C.G.	2490.0R	Ship to Ship
	8291.1	12429.2	16587.1	4069.2T
Ship	8294.2	12432.3	16590.2	4363.6R
	12336.2R	16491.5T	6200.0T	
	13107.0R	17236.5R	6505.4R	
St. By S.S.B.#2	WOM 810	WOM 1215		
Ship to Ship	4143.6	8291.1	12429.2	
SEA GUARDIAN Fla. #8701 BP	Expires 2-27-80 WYU-5821 VHF Modar (HB529)			
	Channels 6-12-22A-26-27-28-70-80A			
(157.125)	Sub Freq. and WX1 and WX2			

H. NAVIGATION CONTROL

1. Surface System

a. Navigation Equipment On Board Surface Support Vessels

R/V JOHNSON

(1) Magnetic Compass - Plath Hanseat I

(2) Gyro Compass - Sperry MK37 with 2 Repeaters

(3) Radar - (a) DECCA 916 and (b) DECCA 914

(4) Loran - North Star 6000 (Loran C)

(5) Auto Pilot - Sperry

(6) Del Norte Navigation System

SEA DIVER

(1) Magnetic Compass - Sperry (2)

(2) Radar - (a) DECCA 1A 916
(b) DECCA 101

(3) Loran - (a) DECCa, DAL-22 double channel, auto tracking, Loran A.
(b) Kelvin Hughes Loran A.
(c) North Star 6000 (Loran C) (1 unit) with LAT and LON

(4) Auto Pilot - Sperry Magnetic Compass Pilot

(5) R.D.F. - Apelco Applied Electronics, Inc. b.

b. Sonar System

The Straza Industries Model 500 CTFM (Continuous - Transmission-Frequency - Modulated) sonar electronic stack is mounted on the forward end of the electronics equipment rack in the center of the sphere. The training mechanism, with hydrophone and projector attached, is mounted on top of the pilot's sphere hold assembly. The high resolution sonar detection and viewing of underwater objects at all bearings and at ranges from 3 to 1500 yards. The system provides both audio and visual outputs and has the capability of maintaining simultaneous contact with multiple targets and markers or transponders.

c. Transponders/BEACONS

One Straza transponder Model 7030 is attached to the support ship's underwater electronics tower and is powered by 14 VDC from the electronics control station on the bridge. When the Straza transponder is interrogated by a signal from the submersible's sonar it transmits a pulse that shows up on the sonar PP1 scope as a "blip" and indicates range and relative bearing to the surface ship. A second model 7030 transponder is carried on the support ship. It is battery powered and can be used as a back up or a location marker at depths of 1000 feet.

Tracking the J-S-L is accomplished with a Honeywell RS7 position indicator. The unit displays a signal received from a beacon mounted on J-S-L. The RS7 displays two channels at one time on the bridge mounted CRT (Cathode Ray Tube). This unit shows range and bearing and can track and display both submersibles simultaneously.

d. Loran C

R/V JOHNSON and SEA DIVER will both use Loran C for navigation.

2. Undersea System

a. Pingers

The Straza pinger is mounted in a bracket on the after "A" frame and is turned on by a saltwater activated switch. The Helle pinger is mounted in a similar bracket on the after "A" frame and is switched on by closing a switch on the sphere electrical control panel.

These pingers are tracked by the support ship with a Straza marker receiver Model 9010/MRM-503 passive tracking sonar. Accurate relative bearings out to 2500 yards on the Straza pingers are normal.

b. Auxiliary Pinger

The auxiliary pingers are all activated by immersion in saltwater and secured by rinsing with freshwater. They are used as back ups for the J-S-L pingers and may be used to mark an underwater location or object and then relocate with the support ship's passive sonar or the J-S-L's active sonar.

c. Doppler Sonar Navigation System

The Sperry SRD-101 Doppler Navigation System consists of the following major components: the transducer assembly, the electronics pressure can, the control and indication unit, and the magnesyn compass.

The SRD-101 employs beams of continuous wave ultrasonic energy, directed obliquely at the ocean floor, to obtain true speed and distance covered over the bottom in the fore-aft and starboard-port directions. Speed and distance are displayed on separate instruments. Drift angle information is displayed on a heading-drift indicator, along with desired magnetic course and actual magnetic heading.

d. Echo Sounder

A data marue digital echo sounder is mounted on top of the sonar stack in the forward part of the pilot's sphere. Power is applied by closing a switch on the sphere is electrical control panel. A Model 3023 transducer is mounted on the after bottom "A" frame.

I. Scientific and Support Equipment

The following lists the equipment to be used during the operations to accomplish the objectives described in Section I. All figures referred to are located in Appendix 6.

1. Datum Casings (Figure 12)

Datum casings are permanent reference points for geological and archaeological surveys. Specifically, datum casings are 10-foot sections of either 3-inch schedule 80 PVC tubing or 2-inch aluminum pipe which are set vertically into the bottom sediments by a water jet leaving 3 feet of their length exposed.

Specifications:

Schedule 80 PVC tubing	3 inch by 10 feet
Aluminum	2 inch by 10 inches

2. Water Jet (Figure 11)

The water jet is a tool for implanting datum casings into bottom sediments and is powered by a 175 gallon-per-minute submersible pump system mounted on a J-S-L submersible. The water jet receives water through 25-foot section of 1-inch pressure hose with quick release connections. The water flow is directed through two 90-degree elbow joints connected to a 10-foot section of 1-inch galvanized heavy wall conduit. With the water jet inside a 10-foot datum casing, the force of the water flow out the open end of the conduit is used to forcefully wash the datum casing vertically into the bottom sediments. To help direct and work the water jet, three positioning quides, or handles, are mounted on the top 24 inches of the conduit.

Specifications:

Horsepower	2 hp
Power Supply	24 volts D.C.
Flow Rate	175 gallons/minute
Outlet Diameter	1 inch
Pressure Hose (4 Sections)	1 inch by 25 inches

Specifications:

Conduit	1 inch by 10 foot heavy wall, Galvanized
Positioning Guides	1/4 inch Steel Rod
Elbows	1 inch inside diameter, Galvanized Steel

3. Submersible Pump System (Figures 11, 13)

The submersible pump system is intended to provide a 175 gallon per-minute flow of water for the underwater operation of both an induction dredge and a water jet for the installation of datum casings. The pump system will be mounted on a J-S-L submersible from which it will receive its 24 volt D.C. power supply. The system consists of a waterproof two horsepower electric motor driving a Keene Engineering P-175 centrifugal pump with a 1 inch diameter quick connect outflow and drawing water through a 2 inch intake with 1/4 inch wire mesh strainer. In operation, the pump system will be controlled from within the submersible, the operators of which will have voice and visual communication with divers utilizing the system.

Specifications:

Horsepower	2 hp
Power Supply	24 volts D.C.
Flow Rate	175 gallons/minute
Outlet Diameter	1 inch
Pressure Hose (4 Sections)	1 inch by 25 inches

4. Induction Dredge (Figure 23)

The induction dredge is a tool for moving loose bottom sediment through vacuum suction. Powered by a submersible pump system mounted on a J-S-L submersible, the dredge uses a 175 gallon-per-minute water flow through 25 foot sections of 1-inch pressure hose with quick release connections. The water is injected into a 2-1/2-inch diameter power jet which, as a venturi eductor, creates the suction which draws water and loose bottom sediments through a 15-foot by 2-1/1-inch diameter flexible suction hose with a 12-inch by 2-1/2-inch jet nozzle. At full capacity the induction dredge will move one cubic yard of loose sand or gravel per hour.

Specifications:

Jet Nozzle	
length	12 inches
diameter	2 1/2 inches
Suction Hose	
length	15 feet
diameter	2 1/2 inches
Power Jet	
diameter	2 1/2 inches
Pressure Hose	
length	25 feet
diameter	1 inch
Power	175 gallon/minute water pump

5. Inclinometer (Figure 25)

The inclinometer will provide a measure of angle of deviation from the horizontal plane. The device consists of a 180 degree protractor with a 6-inch radius, graduated to 30 foot accuracy mounted on the vertical plane with a weighted 6 inch pointed pendulum pivoted at the origin. The protractor and pendulum will be mounted within a clear 1/2 inch stock 3-inch by 6 1/2-inch by 12-inch plexiglass box to prevent disturbance by water currents. The box will be mounted on a 1/2-inch by 3-inch by 24-inch plexiglass base.

Specifications:

Protractor	6 inch radius, 30 foot accuracy
Plexiglass	1/2 inch clear

6. Datum Harness (Figure 14)

The datum harness is designed to provide a quick and accurate distance measured from established datum points. The equipment consists of datum casing rings and measured from established datum points. The harness rings are made of 1/8 inch diameter stainless steel with a 2-inch interior diameter for the aluminum datum casings and a 3 inch interior diameter for the PVC datum casings. Each harness ring has two loops of 1/8-inch diameter stock set to have an outer edge exactly 3 inches from the center of the datum casing. Four different lengths of measured cable (49 feet 6 inches; 24 feet, 6 inches; 9 feet, 6 inches; 4 feet, 6 inches) of 1/8-inches stainless cable with bronze swivel eye snaps will provide basic segments for measurements from the datum casings.

Specifications:

Harness Rings	1/8-inch-diameter stainless stock
Measured cable (each)	1/8-inch stainless cable
	2 bronze swivel eye snaps
	2-1/8-inch stainless thimbles
	2-1/8-inch swage collars

7. Bubble Tube with Electronic Indicator (Figure 16)

The bubble tube level with electronic indicator is used to transfer elevation data from a known datum point to specific locations on the wreck. Once on the bottom, the tube is filled with air. One end of the tube is attached to one of the datum stations and the other end, with the indicator light, is placed next to the point at which an elevation is needed. The free end is then raised or lowered until the level is found at which the light is activated, indicating the plane of the datum point. A measured rule is then used to determine the distance the measured point is below or above the datum plane.

The unit consists of a clear plastic hose with an indicator light at the free end and a float-activated mercury switch at the datum end. The indicator light is connected by wire run through the hose to the mercury switch which is powered by batteries encased in a waterproof box. The mercury switch is mounted in a clear plexiglass box, open at the bottom, which maintains the float level.

Specifications:

Clear Plastic Hose	5/8 inch by 75 feet
Indicator Light	6.3 volt, .25 amp.
Power Supply	6 volt Lanter Battery
Mercury Switch	8 inches by 1-1/2 inches by 2 inches, 1/2 inch plexiglass

8. Portable Grid Square and Camera Mount
(Figures 17, 18, 19, 20, 21, & 22)

The portable grid square and camera mount serves two main purposes: first, to delineate the area that is to be excavated, and second, to provide a stable platform for three-dimensional photo-mapping. The system consists of three components: a base and leg assembly, a photo reference grid, and a camera attachment frame.

The base and leg assembly is composed of a square aluminum frame with four adjustable legs. Standard line levels are attached to the base and leg assembly to ensure precise horizontal adjustment. The photo reference grid is a second and slightly smaller aluminum frame with a permanently attached wire grid. The photo reference grid will be removed while excavation is in progress but, while photo-mapping is being conducted, will be suspended from the base and leg assembly directly on top of the exposed level of excavation.

The camera attachment frame consists of two adjustable A-frames that are connected to the legs of the base and leg assembly and a bar that connects the tops of the two A-frames along which the camera system can slide.

During photo-mapping a 35mm camera with a 28mm lens will be connected to the camera attachment frame. The camera will slide horizontally along the camera attachment frame to provide photomosaic coverage of the excavation. Two additional camera mounts will be utilized; one to connect a remote video camera to the camera attachment frame and the other to connect a profile camera.

Specifications:

Base and Leg Assembly

Frame	5 feet, 6 inches x 5 feet, 6 inches, 2-1/2 inch x 1/4 inch Angle aluminum
Legs	2 inch aluminum tubing, Length 6 inches

Photo Reference Grid

Frame	5 feet x 5 inches, 2-1/2 inches x 1/4 inch angle aluminum

Grid	Stainless steel wire at 1 foot intervals
Camera Attachment Frame	
A-Frames	2 inch aluminum tubing 2-1/2 inch aluminum tubing for sockets
Camera Bar	5 feet, 6 inches x 2 inches aluminum tubing 5 feet, 6 inches x 1/2 inch x 1/2 inch aluminum square stock key

9. Recovery Baskets (Figure 24)

Aluminum recovery baskets are intended to serve as artifacts containers for on site use and for site to surface transportation. The recovery baskets are 30 inches by 30 inches by 15 inches with a hinged top and dividing plates that can be used to divide the interior into 15 inch by 15 inch sections. The baskets are constructed with a 1-1/4 inch aluminum angle stock frame and expanded aluminum mesh top, bottom, and sides. The interior dividing panels are similarly constructed with angle stock and mesh. Each basket also had a latch and a set of nylon lifting straps.

Specifications:

Dimensions	30 inch by 30 inch by 15 inches
Angle Stock	1-1/4 inch by 1-1/4 inch aluminum
Lift Straps	1 inch by 100 inch loops on each end

10. Datum Casing Levels (Figure 15)

The datum casing levels are used during the installation of the datum casings to provide a visual reference to the vertical. Basically, the systems mounts two bubble levels at right angles to each other on a plane that is at a right angle to the axis of the datum casings. When both bubble levels indicate "level" the datum casing is vertical. The datum casing levels are made of 12-inch section of PVC pipe with an interior diameter equal to the datum casing outside diameter and have a 1-1/2-inch flange on one end. The two bubble levels are mounted at a right angle to each other on the flange. Midway down the 12-inch PVC section, two set screws are mounted on opposite sides to secure the datum casing level to the datum casing.

11. Test Excavation Camera System

The camera systen used to document the test excavation consists of a Nikkormatt FT2, 35mm, SLR camera with a Nikkor 28 28mm f3.5 lens and a Sunpak 611 electronic flash. The camera is encased in an Ikelite submersible housing fitted with a dome port for the 28mm lens. The Sunpak flash is encased in a separate Ikelite housing.

VI. EMERGENCY PROCEDURES

A. ADVANCE NOTIFICATION

The Coast Guard base located in Hatteras, North Carolina has been informed, of the operation mission plans and will be monitoring the area in conjunction with its role prescribed by Rules and Regulations of the Marine Sanctuary. Notification of the operation will be placed in the Notice to Mariners.

B. SEARCH AND RESCUE FACILITY AVAILABILITY

Helicopter service for emergency evacuation from the MONITOR site is available from the Coast Guard air-sea rescue coordination center at Elizabeth City, North Carolina. For emergencies the Air Station operations number is (919) 338-3941, ext. 330. For advance preparations, the District office is (804) 398-6231 or Operations Center, (804) 398-6221, Portsmouth, Virginia. There is also a Coast Guard Atlantic Strike Team for oil pollution which has underwater salvage officers at Elizabeth City, North Carolina, (919) 338-1100/338-1556.

C. MEDICAL TREATMENT

Onboard the R/V JOHNSON is a DDC facility which will be used to treat diver decompression accidents. A medical technician will be on site throughout the diving operations. The DDC facility and the medical technician, who will operate the chamber, will meet all the requirements described in NOAA Circular 75-88. Additional medical treatment may be provided aboard R/V JOHNSON dispensary facility. Should an additional, better equipped, facility be needed it will be available from:

Carteret General Hospital
3500 Arendell Street
Morehead City, NC
(919) 726-5151
Contact:
John Yurko, M.D.

Hatteras Medical Center
Hatteras, NC
(919) 986-2388
Contact:
Dan Burroughs, M.D.

Albermare Hospital
P. O. Box 1587
Elizabeth City, NC
(919) 335-0531
Contact:
Robert Polahar

D. POSSIBLE EMERGENCIES AND PLANNED RESPONSES

HBF has developed the following four rescue systems to assist J-S-L submersibles in emergency situations:

1. SEA GUARDIAN/CORD - This unmanned tethered vehicle can be fitted with hydraulic cable cutter or can be used to carry a drop-lock mechanism attached to a hauling wire.

2. RECOVERY REEL - A second J-S-L submersible can be fitted with a reel of hauling wire with a drop-lock mechanism on one end and an inflatable buoy on the other for emergency rescue.

3. Lock-out diver - A diver can be locked out of the disabled submersible or a second J-S-L submersible to use a cable cutter or for general reconnaissance.

4. Emergency buoy - Each J-S-L submersible caries a self deployed emergency buoy which carries 0.19 inch Phillystran rope for attaching a hauling wire (see Appendix 3 for details).

Additional details on emergencies including fire, flooding, entanglement, etc. can be found in Appendix 3.

E. EMERGENCY NOTIFICATIONS

1. Rescue and Assistance Forces

U.S. Coast Guard - See Section VII., B. and Appendix 4.

2. If an emergency situation arises the NOAA Representative on site will report directly to the Officer-in-Charge of Marine Sanctuaries, who will brief, immediately, the Assistant Administrator for Coastal Zone Management, the Director of the MUST Office, and the Director of Public Affairs of the emergency and the steps which have been taken and planned remedial action. Following the close of the emergency situation the events which occurred will be documented for the record.

ATTACHMENT 1

LETTER FROM GORDON WATTS

NORTH CAROLINA DEPARTMENT OF CULTURAL RESOURCES

Raleigh, North Carolina 27611

Division of Archives and History
Larry E. Tise, Director

Sara W. Hodgkins, Secretary
James B. Hunt, Jr., Governor

Underwater Archaeology Branch
Division of Archives and History
P.O. Box 58
Kure Beach, North Carolina 28449
February 16, 1979

Commander Floyd Childress
National Oceanic and Atmospheric Administration
Office of Coastal Zone Management
3300 Whitehaven Avenue, N.W.
Washington, D.C. 20235

Dear Commander Childress,

Enclosed please find some additional material we have prepared concerning the objectives and conduct of the archaeological investigations proposed for the project in August. Each of the objectives has been selected from research requirements that have been identified in the course of preparing the MONITOR Marine Sanctuary Research and Development Concept. As you know, a wide variety of knowledgable professional archaeologists, engineers, historiens, conservators, and other scientists have contributed to the preparation of these research priorities.

Perhaps the most critical priority for investigation at the site is establishing permanent datum stations that can be utilized to control the collection of all on-site data. The system that we have selected will permit accurate provenience to be established for all photography, mapping, excavation, sampling, and testing. It can be utilized with both conventional mechanical and/or sophisticated electronic/acoustic positioning systems either inside or outside the confines of the hull. Should the decision to recover the vessel be made in the future this system will be sufficient for pre- and post-recovery data collection.

Because the remains of the MONITOR have never been tested archaeologically, no information exists concerning the nature and extent of the archaeological record preserved at the site. Answers to these and other questions concerning theo feasibility of conducting work at the site must be establishedo before responsible management decisions can be made. To provide insight into these and a myriad of other engineering, conservation, and historical questions, test excavations must be carried out inside the confines of the hull. The proposed investigation represents the first of several that will be required.

To assist in developing more comprehensive engineering evaluations of the condition of the wreck, answering historical questions about the ship's design and construction and assessing conservation problems that the wreck represents, hand-held photographic and video tape records of the site must be collected. These records will be designed to provide insight into both general and specific questions that have been identified in the course of preparing the MONITOR Marine Sanctuary Research and Development Concept. In response to previously raised engineering and conservation questions, the present attitude of the hull will be established and a series of samples from selected structural features will be collected for laboratory analysis.

While this work represents only one of the initial steps in the conduct of a systematic analysis of the wreck, the project will generate a tremendous amount of previously unavailable information about the MONITOR. If responsible decisions concerning the future of the site are to be made, this and additional data will be essential.

Best regards,

Gordon P. Watts, Jr.
Head, Underwater Archaeology Branch

GPW/h

ATTACHMENT 2

LETTER FROM LT DAVID H. PETERSON

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
Rockville, Maryland 20852

MAY 1 1 1979

TO: LCDR Floyd Childress
Office of Coastal Zone Management

FROM: LT David H. Peterson
National Ocean Survey

SUBJECT: Review of Diving Regulations Which Pertain to the Monitor Expedition

At the request of the Assistant Administrator for Coastal Zone Management, I have been detailed from my present assignment to prepare for you an assessment of two issues related to the proposed diving operations in the MONITOR Marine Sanctuary. I have been asked to assess the regulatory aspects of the proposed diving operation as well as its overall safety. The comments set forth below are offered in my capacity as a member of the NOAA Diving Safety Board and a former Assistant to the NOAA Diving Coordinator.

<u>Regulatory Aspects.</u> The Operations Manual describes the overall program as a "cooperative project" funded by NOAA, pursuant to authority prescribed under PL 92-532, and involves the State of North Carolina and the non-profit Harbor Branch Foundation as cooperators with NOAA.

The MONITOR wreck site lies beyond the 3-mile limit offshore in the area described by PL 95-372 as "Outer Continental Shelf Lands." The 1978 Amendments to PL 95-372, specifically Section 22(a), assign to the Coast Guard the responsibility of enforcement of safety regulations issued pursuant to PL 95-372. On February 1, 1979, the Coast Guard commercial diving regulations became effective. These safety regulations, found in 46 CFR 197, Subpart B, directly apply to all commercial (i.e., for hire) diving operations on the Outer Continental Shelf Lands, and were issued under the authority prescribed in PL 95-372.

A careful reading of 46 CFF 197, Subpart B, Section 197.202, which concisely defines the applicability of these regulations, indicates that diving operations undertaken by Federal agencies on Outer Continental Shelf Lands are not commercial in nature, and thus do not fall under the direct jurisdiction of the U.S. Coast Guard.

The operations described in the Operations Manual are to be undertaken within circumstances under which the NOAA Diving Regulations clearly apply. Reference is made to four specific paragraphs within NDM 64-23 of September 15, 1976, which clearly define a NOAA responsibility for the safety of this proposed diving operation: paragraphs

2c; 3a(3)(i); 4a(2); and 4b(4). The paragraphs deal with the scope (applicability) of the Regulations, the approval to use mixed gas and rebreathers, a formal review of budgeted non-saturation diving projects, and diving by non-NOAA certified personnel, respectively.

While the NOAA Diving Regulations do not define specific operating safety standards for diving modes other than compressed air scuba, they do set forth the stated NOAA intent to conduct diving operations under its auspices in a manner most likely to minimize accidental injury or occupational illness. With this stated intent, despite the fact that U.S. Coast Guard commercial regulations are not directly applicable, NOAA is obliged to consider such established Federal commercial regulations as reasonable standards of care to be exercised when conducting Federal diving operations of a similar nature to those covered by such regulations.

A thorough review of 46 CFR 197 will reveal that even the Coast Guard regulations do not prescribe safety standards for "submersible lock-out" diving. However, without stretching the regulatory imagination too far, it can be perceived that the sections of the Coast Guard regulations dealing with closed diving bells and the mixed gas surface-supplied diving mode describe a situation parallel to submersible lockout diving. If NOAA is to exercise a reasonable standard of safety in the proposed diving operations, such operations should be conducted under the requirements of both the NOAA Diving Regulations and the U.S. Coast Guard commercial diving regulations.

Overall Safety. Lock-out diving operations will be required to complete all five objectives of the project. The general technique of this mode of diving, as such is described in detail in the Operations Manual, is in essential conformance with its U.S. Navy equivalent, as described in the Navy Diving Manual, Chapter 12. Since the submersible is classed by the American Bureau of Shipping, its internal and external design features for its lockout capability conform to specifications and safety and operational guidelines for underseas equipment described in the ABS Guide for the Classification of Manned Submersibles. It can thus be said that the submersible is safely designed for its intended use and no significant hazard is imposed upon a properly trained diver following specified operational lockin/lockout procedures.

Despite the fact that the operations are being conducted upon a wreck, the circumstances with this particular wreck are not those normally associated with wrecks. The unusual situation discussion of wreck diving found in Chapter 6 of the Navy Diving Manual does not appear to pertain in this wreck's situation and condition. None of the described tasks assigned in the Operations Manual appear to impose unusual hazard to a diver on, in, or around the wreck. These tasks require scientific and technical expertise to accomplish which a properly trained diver/scientist should be capable of. It does not appear that these tasks will at any time place a diver in a situation where overhead access is denied or in a situation where an unstable boundary will exist, or where he will be in close proximity to overhead hazard. (This is particularly true with respect to the planned excavation activities, with expectations of a four-foot deep excavation in sandy substrate.)

The Operations Manual describes a tri-party command-control structure on-site, responsible to an overall program manager at the headquarters level. The responsibilities of these individuals lie along program, operations, and science lines. This split of responsibilities is a useful checks and balances system with each having a specific set of circumstances where he may dictate (with authority) whether or not any given activity will proceed during the project.

cc: Director, NOAA Diving Program

APPENDIX 1

Preservation Plan

I Introduction

Excavation of the proposed 5 x 5 foot test unit potentially will produce a quantity of artifacts, samples, and other materials which require special handling, recovery, stabilization, cleaning, analysis, and conservation. The archeological marine context is a dynamic situation in which water, temperature, minerals, and biological organisms act upon the surface of the site, creating anticipated physical and chemical alterations.

The effects of selective preservation in an underwater archeological site may vary from excellent preservation to the total loss of an artifact. Beneficial preservation can be seen in the action of mineral replacement of organic material in bone. In contrast, destruction of materials is exemplified by the desolation of cellulose in wood. For metals, corrosion is an electolytic process, changing from metal, which is an unstable state for most metals, to mineral. Materials above the seabed will be covered with biological and chemical concretions.

After excavation, exposure to air can destroy the artifacts in an amazingly short amount of time by accelerating the deterioration process. Bone will warp, ivory will crack, ceramics may start to spall and lose their glaze, metal oxidizes to dust, leather will mildew, and wood cracks and warps. All of this can be prevented by properly devising a strategy prior to operations to process the excavated materials in accordance with professional techniques for conservation.

Therefore, the purpose of the preservation plan is to outline the artifact processing phase of the 1979 MONITOR operations. The processing is to be based on proper recovery, storage, documentation, analysis, conservation, and curation. The future curatorial responsibilities of the excavated materials to insure long-term preservation during both storage and exhibit has been recognized by NOAA in conjunction with the Navy Historical Center.

II Field Processing

While the specific nature and precise amount of the materials are unknown, the test excavation location and size permit the type and volume of material to be roughly calculated. Examination of photographic evidence, plans, and specifications for the ship indicates that a volume of approximately 88 cubic feet of material must be removed if the excavation is to be carried to deck timber. Based on examinations of other iron wrecks of the same period, it may not be unreasonable to assume that 15 per cent or approximately 13 cubic feet of the material consists of overburden that will be removed in process of excavating. Historical and structural data indicates that the remaining 85 per cent or 75 cubic feet of material will be composed of structural remains of the vessel, fittings and supplies stowed below the ward room and officers' quarters deck, and the personal and official effects of the captain.

With the exception of structural components of the ship, all material in the test location is expected to be of manageable size and no unusual problem to excavate, recover, and preserve. In fact, avoiding substantial fragments of the vessel structure will be one of the major considerations in determining the precise location of the test excavation. To facilitate recovery a specially designed container has been prepared to transport artifacts to the surface. Constructed of expanded aluminum, the recovery basket will be capable of handling 7.8 cubic feet of material. A partition will permit four 5 gallon watertight containers to be used for transporting small or delicater materials. Once the recovery basket has been packed and the lid locked, a 500 pound capacity lift bag can be attached to a harness of nylon webbing. At the surface, the basket can be recovered by rubber boat and easily hoisted aboard the R/V JOHNSON.

On board the R/V JOHNSON artifacts will be handled by conservators from the Underwater Archeological Branch, photographed, cataloged, and repacked in cases constructed for wet storage. As required the excavated materials will be shipped to Hatteras aboard the NOAA vessel and once ashore, all materials will be transferred to the North Carolina Division of Archives and History survey vessel. Under the supervision of a conservator, all materials will be repacked in temporary containers with fresh water and chemicals or boicides to retard deterioration. During the project all artifacts and materials recovered from the site will be stored in a secure location aboard the N.C. vessel or transported to the appropriate facilities ashore. At the conclusion of on-site activities, material recovered from the test excavation will be shipped aboard the Division of Archives and History research vessel to Carolina Beach, North Carolina, and transported to the Preservation Laboratory at the Fort Fisher Historic Site near Kure Beach, North Carolina.

III Documentation of Artifacts

Once the artifacts have reached the North Carolina Preservation Lab at Fort Fisher Historic Site, they will be packed in separate tanks and a schedule for analysis, cleaning, and conservation of the artifacts will be prepared. Once this schedule has been developed and appropriate conservation processes determined, treatment of the material can be initiated. With adequate staff, supplies, equipment, and facilities it should be possible to complete this work by October 1, 1981.

Documentation begins at the point of recovery while excavation is proceeding. The archeologist will make recordings on tape and submersible slabs; on deck of the research vessel the conservator and assistants will record relevant data in an on-going log book. Initiated at this time, will be a uniform cataloging system for the excavated materials regardless of where the artifacts are sent for processing.

Analysis and documentation will be concerned with how the artifacts were made, what materials they are composed of, and the changes that have taken place within the object and why these changes have happened. Analytical techniques if equipment and staff are available, range from wet chemistry, metallograpy, radiography, polarized light microscopy, to sophisticated instrumental analysis using infrared spectroscopy, atomic absorbtion and neutron activation analysis. This information could identify the materials of which the object is composed, the use for which the object was intended, as well as the processes of chemical and physical deteriotation which have occured. This data allows the conservator to develop conservation treatments, but just as important, this information and his/her treatment methodology is pertinent in improving standard methods and developing new methods in conservation. The integrity of the artifacts is the foremost priority of the conservator, but his documentation and analysis will aid future researchers of the MONITOR and conservators in formulating predictive models for the MONITOR's preservation and other underwater archeological sites.

IV Conservation Techniques

Many factors will have to be considered in determining the most appropriate conservation method for treating artifacts recovered from an archeological site:

1. Composition of the objects - inorganic and/or organic

2. Cultural modifications of the objects - technological and functional

3. Condition of the objects - effects of physical, chemical, and biological environmental actions.

4. Projected goals for the materials recovered - analysis, research, and/or display.

5. Staff, equipment, cost

Because of the complexity of these facotrs, treatment of the artifacts can not be proposed in advance of their recovery, and can only be done after recovery by a conservator experienced in processing artifacts from underwater sites.

The following briefly outlines the general phases of conservation techniques relevant to anticipated types of materials to be recovered from the 1979 operations. Alternative conservation techniques are addressed below for a few of the processing phases.

1. Iron

The iron plates, ribs, beams, and miscellaneous ferrous artifacts from the MONITOR will probably comprise the majority of objects recovered.

a. Stabilization
   1] Annealing in a reducing atmosphere (hydrogen reduction process)
   2] Electrolytic reduction
   3] Electrochemical reduction
   4] Water difussion - intensive washing and/or steaming
b. Mechanical Cleaning
c. Rinsing and Drying
d. Consolidation
   1] microcrystalline wax
   2] epoxy resins
   3] polyeurethane

2. Copper

a. Stabilization
   1] Electrolytic reduction
   2] Immersion in Benzotriozole in ethanol
b. Mechanical Cleaning
c. Chemical Cleaning
d. Rinsing and drying
e. Consolidation
   1] microcrystalline wax
   2] Incralac

3. Lead and Tin

a. Stabilization
   1] Electroytic reduction
b. Mechanical cleaning
c. Chemical cleaning
d. Drying
e. Consolidation
   1] microcrystalline wax
   2] polyurethane
   3] epoxy resins

4. Wood

   a. Mechanical cleaning
   b. Chemical cleaning
   c. Stabilization
      1] Polyethylene Gycol (PEG)
      2] Tetraethyl Crthosilicate (TEOS
      3] Freeze Drying

5. Leather

   a. Mechanical cleaning
   b. Wet cleaning
   c. Stabilization
      1] Tetraethyl Orthosilicate (TEOS)
      2] Freeze Drying
      3] Polyethylene Gycol (PEG)

6. Glass

   a. Wet cleaning
   b. Chemical cleaning
   c. Drying
   d. Consolidation as necessary

7. Ceramics

   a. Wet cleaning
   b. Chemical cleaning
   c. Drying
   d. Consolidation as necessary

V. Conservation Facilties

A. Option I - Ft. Fisher Preservation Laboratory

The Preservation Laboratory at Ft. Fisher, North Carolina is presently undergoing extensive renovation and enlargement to prepare for involvement in the conservation of artifacts from the MONITOR, and to provide the Underwater Archeology Branch with a facility capable of providing more consistent, scientific conservation treatment than has been possible with the present, outdated facility.

The design calls for the renovation and enlargement of the present laboratory, and for the construction of a utility building on the site of the present sandblasting shed. The former building will be comprised of wet and dry storage areas for artifacts, a laboratory, a darkroom, and a drafting and records room. The latter building will house the portable sandblaster and air compressor, the x-ray facilities, a chemical storage area, and a large work area for preservation.

The entire laboratory building, when completed, will have floor area of approximately 1475 square feet. It will have flouorescent lighting, a concrete floor with a floor drain, and block walls. The processing area of the laboratory will be constructed and furnished so as to provide efficient movement of artifacts throughout the different stages of preservation treatment. Artifact flow will describe a circular counter-clockwise movement around the sides of the room, starting in the north-west quadrant and ending in the northeast quadrant.

The northwest quadrant of the laboratory building will be used for wet storage of artifacts and mechanical cleaning, including sandblasting. The cabinet sandblaster will be ducted through the wall to a dust collector. The majority of floor space in the wet storage area will be taken up by Nalgene and steel tanks of various sizes filled with water and used to store artifacts prior to treatment.

For the initial mechanical cleaning and examination of artifacts there will be a heavy-duty metal sink and drainboard, which will supplement those in the wet storage area, a lapidary saw, and work bench area with storage space underneath. The entire west wall of the processing area in the south-west quadrant will be used for electrolytic reduction. Stainless steel and Nalgene tanks of various sizes will be wired into power supplies as needed, and will also be used for chemical treatment of large wooden and metallic objects in this same area when necessary. An exhaust hood will run over-head to draw off hydrogen gas and other flammable or noxious chemicals.

There will be a four foot space along the adjacent south wall of the southwest quadrant which will also be used for electrolysis and chemical tanks. Another fume hood will be installed, so the electrolysis area will also have adequate ventillation. Also, underneath this fume hood will be a wall assembly with sink, two or three large tanks, storage space, and work space for rinsing and mechanical cleaning after electrolysis or chemical treatment. A portable steam generator will be placed east of the cleaning tanks to provide steam for boiling and hot water rinses.

The middle section of the processing area will be occupied by two work areas. They will be used for wet chemical analysis, precision equip-ment storage, and data specific-ion meter, glassware, hot plate/stirrer, magnifier/ illuminator, measuring instruments, and two volt/ammeters.

The plumbing and drainage pipes for the processing areas will run around the sides of the walls, and there will be drain outlet on the western wall near the electrolysis tanks so that chemical and electrolysis tanks can easily be drained into a chemical disposal tank.

In the southeast quadrant, a large equipment area will run approximately twenty feet along the south wall of the processing area. Located along this portion of the wall will be the water deionizer, the still, the muffle furnace, the freeze dryer, storage cabinets, and work benches. On the adjacent east wall, there will be a standard kitchen range and storage and shelf space on the remaining portion of the wall. In the middle of the area will be tow flat work tables. which will be used for the coating of artifacts. Each table will have a small built-in shelf or cabinet for the temporary storage of paint, wax, and other coatings, and utensils.

In the northeast quadrant will be the photographic dark room, drafting and records room, and artifact storage room. The conserved artifacts will be placed in the storage area until they are ready to be transported to a museum or historic site. The walls will be lined with shelves and a temperature/relative humidity recorder.

The utility building to be built at the site of the present day sandblasting shed will measure 25 feet by 45 feet or 1125 square feet (interior space) and will be divided into three areas all with block walls, concrete floors, and flourescent lighting.

The northeast part of the building will be used for sandblasting and will be equipped with overhead exhaust fans. This room will house the large air compressor, the portable sandblast machine, a small workbench, and a storage closet for maintenance tools, oil, dessicant, gloves and other related appartus. Sand will also be stored in this room on wooden pallets.

The northwest part of the utility building will be used for chemical and paint storage. It will be outfitted with racks for 55 gallon drums, storage shelves, and at least one metal cabinet that can be locked for the storage of extremely noxious or flammable chemicals. This room will also be equipped with several metal and plastic buckets, siphon pumps, and utility scale for dispensing and measuring chemicals.

The south end of the utility building will be outfitted with a heavy duty galvanized sink and drainboard, hot and cold running water, a floor drain, and several cabinets and work benches arouns the walls. The x-ray machine will be installed in one corner, and will require approximately 30 square feet of floor area, with lead shielding or block walls enclosing this area. The large open area in the center of the room will be used by the archeologist to clean and examine lithic, ceramic, and other prehistoric and historic artifacts.

B. Option II

In the event that North Carolina's Preservation Laboratory does not appropriate financial support in order to hire a conservator and expand the laboratory facilities, the exacavated materials will be sent to other facilities for conservation. The following conservation laboratories have discussed with NOAA (OCZM) their interest in the present 1979 operation's conservation phase:

1. Harpers Ferry
National Park Service
Museum Services
Harpers Ferry, W. Va.
(304) 353-6311

A representative from the NOAA Office of Coastal Zone Management has visted the Laboratory at Harper's Ferry where they were told that facilities were available to conduct the conservation.

2. South Carolina Institute of Archeology and Anthropology
University of South Carolina
Columbia, S.C. 29208
(803) 777-8138

The Office of Coastal Zone Management contacted the S. C. Institute of Archeology and Laboratory and were informed that the facilities were available to conduct conservation procedures of metal and ceramic artifacts from the 1979 operations.

3. Bureau of Historic Sites and Properties
Division of Archives, History, and Records Management
State of Florida
Tallahassee, Florida 32304
(904) 487-2333

The Office of Coastal Zone Management contacted the Florida Bureau of Historic Sites and Properties' Conservation Lab and was informed that they have the facilities to handle the conservation of inorganic as well as organic materials from the MONITOR's test excavation.

4. Texas Archeological Research Center Laboratory
University of Texas
Balcones Research Center
Burnet Road
Austin, Texas 78758

A representative from the Office of Coastal Zone Management visted the facilities at the Texas Archeological Research

Center and was informed that they are interested and have the facilities to conduct the conservation of both organic and inorganic materials from the 1979 test excavation.

5. Chief Conservation Division
   National Historic Parks and Sites Branch
   1570 Liverpool Court KIA OH4
   Ottawa, Ontario

A representative from the Office of Coastal Zone Management visted and toured the Laboratory Division and was informed on various aspects of the science of conservation. The Division stated that they would be interested in providing advice and student interns as assistants to the Laboratory that conducts the conservation of the MONITOR's artifacts.

6. Maine State Museum
   Conservation Laboratory
   Auguste, Maine 04333
   (207) 289-2301

The Office of Coastal Zone Management has contacted the Maine State Museum Conservation Laboratory and they have acknowledge their interest in the conservation of organic and inorganic artifacts from the 1979 test exacavation.

7. Anthropology Conservation Laboratory
   Museum of Natural History and Museum of Man
   The Smithsonian Institution
   Washington, D.C. 20560
   (202) 381-5378

The Anthropology Conservation Laboratory informed the Office of Coastal Zone Management that they are interested and available for review and advice. In addition, services can be arranged with available contacting conservators who have access to conservation facilities in order to process the organic materials from the 1979 test excavation.

8. New York Division of Historic Preservation
   Peebles Island Collections Care Center
   Waterford, N.Y. 12188
   (518) 474-2735

The Office of Coastal Zone Management contacted the Collections Care Center and was informed that the Center had the facilities to conduct the conservation of medium-sized metallic artifacts from the 1979 test excavation.

APPENDIX 2

Resumes of Key Personnel

LCDR Floyd Childress
Director, Operations and Enforcement
Sanctuary Programs Office
National Oceanic and Atmospheric
Administration

3300 Whitehaven Street, N.W.
Washington, D. C. 20235
202/634-4236

LCDR Childress graduated from New Mexico State University with a Master's Degree in civil engineering. He accepted a commission with the Coast and Geodetic Survey (now the NOAA Corps) in 1969. During his career he has spent four years at sea aboard the NOAA Ship DISCOVER as navigation officer and later as the executive officer aboard the NOAA SHip FERREL. His association with submersibles began in 19 as operations officer for NOAA's Manned Undersea Science and Technology office using IUC's BEAVER and General Oceanographics NEKTON GAMMA and later as the NOAA Representative during the 1977 cooperative project with the Harbor Branch Foundation to use the JOHNSON-SEA-LINK I and II to photograph the USS MONITOR and recover artifacts from the site. He has been involved in all research projects at the MONITOR Marine Sanctuary since its designation in 1975. In the past, he served as the National Ocean Survey's Diving Officer responsible for the diving activities of personnel assigned to the vessels of the NOAA fleet. He holds NAUI Assistant Instructor and NOAA unlimited certifications. Since 1977, he has been responsible for management of NOAA marine sanctuaries and is presently Director of Operations and Enforcement for the Sanctuary Programs Office within the Office of Coastal Zone Management.

LT Ted Lillestolen
Sanctuary Operations Officer
Sanctuary Programs Office
National Oceanic and Atmospheric
Administration

3300 Whitehaven Street, N.W.
Washington, D. C. 20235
202/634-4236

LT Lillestolen graduated from Queens College, apart of the City University of New York, with a Bachelors Degree in Earth and Environmental Science. He accepted a commission in the NOAA Corps in 1975 and spent his first sea assignment on the NOAA Ship PEIRCE conducting hydrographic surveys along the east coast and in the Gulf of Mexico. Duties while on board include bridge and computer officer, diving officer and Acting Operations Officer. Since 1977 he has been assigned to the Office of Coastal Zone Management with primary responsibility for managing the MONITOR Marine Sanctuary. LT Lillestolen has been involved in developing the master plan for the sanctuary and the development of this operations manual. He also served as Chief Scientist during the Deep Water Survey in the Key Largo Marine Sanctuary in Florida.

Gordon P. Watts, Jr.
Head
Underwater Archaeology Branch
North Carolina Division of
Archives and History

Underwater Archaeological
Research Unit
Division of Archives
and History
Post Office Box 58
Kure Beach, NC 28440
919/458-5203

Mr. Watts began his career in underwater archaeology in 1968 mapping the Colonial town of Woodstock, North Carolina, which lies underwater. Following this research he served as Salvage and Exploration Field Agent for the Florida Division of Archives conducting underwater archaeological research projects for the Bureau of Historic Sites and Properties. Areas surveyed include: Little Sale Springs, Warm Mineral Springs, and West Turtle Shoals. In 1972 he assumed the position as Underwater Archaeologist for the State of North Carolina's underwater archaeological resources. Areas surveyed include: Newkirk House Site, Fort Branch, Yorktown, Virginia, Chestnut Neck, New Jersey, Alma, Georgia and Tombigbee River. Mr. Watts has also been involved in running Work Study Programs and has also been director and co-director of various Marine Archaeology Field Schools in North Carolina. In 1978 he assumed his present position as Head of the Underwater Archaeology Branch for the State of North Carolina. Since October 1972, his involvement on the MONITOR project has been a continuous undertaking involving extensive archival investigation of the historical background of the vessel. In 1977 Mr. Watts was the Archaeological Advisor during the Photogrametric Survey at the MONITOR M.S. sponsored by NOAA and the Harbor Branch Foundation, Inc. During 1978 he has also been involved in the preparation of the MONITOR Marine Sanctuary Research and Development Concept.

John Broadwater
Nautical Archaeologist
Virginia Research Center
for Archaeology

c/o VA Research Center
for Archaeology
Wren Kitchen, College of
William and Mary
Williamsburg, VA 23186
804/253-4836

Mr. Broadwater received his B.S. in Electrical Engineering in 1966 from the University of Kentucky. He began his career in archaeology in 1972 when he co-founded the Marine Archaeological Research Services Corporation in Southport, NC. Although he terminated his full time position with the company in 1974 he still holds the position as Vice-President. Mr. Broadwater currently holds the position as Nautical Archaeologist, for the State of Virginia Research Center for Archaeology. Since 1973

John Broadwater (cont'd.)

his involvement with the MONITOR has included the historic wreck. He was a member of the archaeology team aboard the R/V ALCOA SEAPROBE during a survey of the U.S.S. MONITOR in 1974.

Richard W. Lawrence
Archaeologist II
North Carolina Division of Archives and History

Archaeologist II
Underwater Archaeological Research Branch, Division of Archives and History
Post Office Box 58
Kure Beach, NC 28440
919/458-5203

Mr. Lawrence began his career in archaeology in 1973 doing archaeological field work at Fort Larned National Historic Site, Kansas. For a brief time in 1974 he worked as a volunteed archaeologist in Oldnuai Gorge, Tanzania under the direction of Dr. Mary Leakey. In 1975 he assumed his present position as archaeologist for the State of North Carolina developing an underwater archaeology program, investigating and managing underwater archaeological resources. He has been involved in running various Marine Archaeology field schools and has surveyed various sites including the Civil War Federal gunboat PICKET near Washington, NC, the Fort Fisher Gun Emplacement in New Hanover County, NC, and Tombigbee River. During 1978 he has been involved with the preparation of the MONITOR Marine Sanctuary Research and Development Concept.

Roger W. Cook
Operations Director
Harbor Branch Foundation, Inc.

RFD 1, Box 196
Fort Pierce, Florida 33450
305/465-2400

Roger W. Cook's career as an underwater specialist began while in the Navy's underwater demolition team. The use of hand-held sonar and Swimmer Propulsion Units from Navy Fleet Submarines were among his duties. Following his naval service, Mr. Cook worked for the Pacific Missile Range on Kwajelein in the Marshall Islands recovering missile wreckage and components. During this time, he was trained by representatives of Perry Submarine Builders as pilot of the PC3A submarine; a dry, two-man submersible rated to 300 feet. He logged more than 70 dives in this submersible. From 1966 to 1972, Mr. Cook was employed by Ocean Systems, Inc., as Chief Pilot for the Link-designed diver lock-out submersible DEEP DIVER. He logged more than 80 dives at sites ranging from Newfoundland to Europe and the Caribbean. Most of these dives were lock-out, two were saturation dives. DEEP DIVER, Roger Cook (cont'd.)

depth rated to 1350 feet, was used for work with the U. S. Navy under the Search and Recovery contract. This work also included use of an ADS IV (Advanced Diving System) to recover crashed aircraft and other objects in depths greater than 200 feet. In 1972, Mr. Cook joined Perry Submarine Builders as Project Supervisor for the designing and supervision of construction for the complete outfitting of a one-atmosphere, 5-man personnel transfer bell. He then procured and adapted a support vessel for the PTB. He piloted 41 dives in the PTB. Since January of 1974, he has been with Harbor Branch Foundation, Inc., a not-for-profit corporation engaged in pollution studies, ocean science and engineering research and development. As Operations Director, he is repsonsible for planning and directing the missions of the foundation's research vessels, submersible support ships, and the J-S-L I and II, Harbor Branch's aluminum and acrylic submersibles. Through his supervision and training for the 4-man crafts, these submersibles are used for diver lock-out which serve the marine scientists at Harbor Branch with the capability to observe, collect living samples, photograph, chart and measure features and phenomena of the undersea environment heretofore not possible for surface oceanographic ships. Mr. Cook has directed more than 100 scientific cruises thus far at Harbor Branch, the most recent being a 600' lock-out dive off the coast of Fort Peirce, Florida, the second deepest on record from a submersible. The record lock-out dive, 700 feet, was performed by him from the Perry-Link DEEP DIVER in 1968. He has personally logged over 100 bell dives. In 1977 Mr. Cook was the Operations Director during the Photogrametric Survey at the MONITOR Marine Sanctuary sponsored by NOAA and the Harbor Branch Foundation.

Joseph L. Morgan
Master, Vessel R/V JOHNSON
Harbor Branch Foundation, Inc.

RDF 1, Box 194
Fort Pierce, Florida 33450
305/465-2400

Mr. Morgan began his career in boating in the early 1930's as deckhand and operator of water taxis and sport fishing vessels in Southern California. In 1943, he branched into towboat work as Captain, and from March 1945 to March 1946, Tugmaster in the U. S. Navy, San Francisco Area. In 1946, after an Honorable Discharge, he returned to Tugmaster duties in Long Beach, Los Angeles Area harbors, and Coast-wise towing. From 1966 to 1969, he was engaged by Offshore Constructors as Bargemaster and expeditor for offshore drilling operations, Santa Barbara Area, and Cooks Inlet, Alaska. From 1969 to 1974, he was Engineer, Captain and Manager for General Marine Transport Company of Santa Barbara, California. June 15, 1974, to present time, he has been Master of the R/V JOHNSON, Harbor Branch Foundation.

Jeffrey R. Prentice
Submersible Pilot/Diver
Harbor Branch Foundation, Inc.
RFD 1, Box 194
Fort Pierce, Florida 33450
305/465-2400

While at the University of Puerto Rico, working on a masters degree in ichthyology, Jeffrey Prentice was Dive Master under the Diving Supervisor, and Emergency Team Leader in charge of the recompression chamber. Since 1973, Mr. Prentice has worked with Habor Branch Foundation, Inc., in all phases of submersible operations. His responsibilities have included installation, operation and maintenance of the decompression chamber facility aboard R/V JOHNSON; he is a submersible pilot, group leader and at sea, operations director. He is a lock-out diver with two open water dives at 500 feet. While working with Harbor Branch, Mr. Prentice was temporatily assigned to the Duke Hyperbaric Chamber Facility where he was a diver on two 1000' dives and two 720' dives. These dives were made to evaluate trimix gas versus a straight Heliox mixture. Mr. Prentice was also an active participant during the Photogrametric Survey at the MONITOR Marine Sanctuary in 1977.

Richard C. Tietze
Manager, Mechanical Engineering
Research and Development
Harbor Branch Foundation, Inc.
RFD 1, Box 194
Fort Pierce, Florida 33450
305/465-2400

Mr. Tietze began his career in Deep Ocean Diving Systems in 1966 working with the Sea Diver Corporation (Man-in-Sea Program, Mr. E. A. Link). Since then he has worked with Ocean Systems, Ads-4, Advanced Diving Systems, and as a Research and Development Engineer with the Smithsonian Institution, Fort Pierce Bureau. Presently, and for the past five years, Mr. Tietze has headed up the Mechanical Research and Development Department for Harbor Branch Foundation. During the past four years, he has been developing and operating the Harbor Branch Foundation's CORD (Cabled Observation and Rescue Device) systems. Mr. Tietze was involved in the Photogrametric Survey at the MONITOR Marine Sanctuary in 1977.

APPENDIX 3

DDC Facility and
Life Support Systems

Flooding

1. <u>Uncontrollable</u> - It is highly unlikely that J-S-L I could encounter an uncontrollable flooding situation without having a collision with another vessel or submerged object. It is also doubtful that the diver compartment would be penetrated in a collision. One of the main ballast tanks could be pierced and rendered almost useless, but the J-S-L I could surface on the other tank and if necessary the battery pod could be dropped. The most vulnerable part of the J-S-L I is the plexiglass sphere that could crack if it comes in contact with another hard object at a combined speed of 1.81 knots on the surface to 4.77 knots at 1000 feet. Evidence to date shows that the hull may crack but would probably stay together and not leak due to external pressure holding it in compression. If this was the case, the J-S-L I should not attempt to surface above 100 feet. At that depth divers would rig securing lines to the J-S-L I frame to be winched under the handling system for recovery. The action to be taken depends on the situation as follows:

a. If the diver compartment has a seal and the J-S-L I is at 240 feet or less:

(1) Blow main ballast.

(2) Release the emergency buoy.

(3) Thruster up if possible.

(4) If the crack is in the lower two-thirds of the sphere, and water is coming in, pressurize as necessary.

(5) Blow all remaining ballast.

(6) Inform the support ship and diver compartment.

(7) Secure electrical power as dictated by the flooding.

(8) Don emergency regulators and face masks as necessary.

(9) Drop the battery as a last resort.

(10) When the J-S-L I arrives on the surface, stay in the submersible, turn on the flasher, communicate if possible and maintain positive buoyancy until help arrives.

b. If you have divers outside or the J-S-L I is below 240 feet:

(1) Inform the surface ship and the divers that you are going to abandon the sphere, enter the diver compartment and surface.

(2) Secure air bank hull stops.

(3) Open mixed gas to both H.P. air and H.P. gas manifolds.

(4) Tell divers to blow down.

(5) Don emergency regulators and face masks.

(6) Release the emergency buoy.

(7) Open oxygen bank cross-connect.

(8) Secure oxygen bleed to sphere.

(9) Open diver compartment vent valve.

(10) Turn on flasher.

(11) When the diver compartment is blown down, flood sphere and open hatch. (Leave sphere flood open.)

(12) Send observer back to divers compartment.

(13) Lock all ballast tank vent valves shut.

(14) Crank battery release all the way open.

(15) Open diver compartment sample valve.

(16) Open both air bank hull stops. (This will put your emergency breathing regulator back on air so hold your breath.)

(17) Swim back to diver compartment.

(18) Have a diver shut and dog the sphere hatch and remove the lead from the after lead tray.

(19) Close "A" and "B" hatches.

(20) Over pressurize and blow bilge ballast tank.

(21) Blow main ballast tanks.

(22) Open sample valve to sphere.

(23) Start decompression as soon as practicable.

(24) Stay in submersible and keep main ballast tanks blown.

(25) Upon receiving the word from the sphere to blow down, the divers should secure the diver compartment atmosphere sample valve and commence blowing down with the main gas supply. If the main gas supply pressure gets down to within 200 PSI over external water pressure before "A" hatch opens shift to the auxiliary gas bank. Tell the pilot's sphere on the sound powered phone, if working, that you have shifted to auxiliary gas supply. When "A" hatch opens one diver should swim up to the sphere to assist.

2. Controlled Flooding (leaks) - the following type leaks might occur anytime at any depth:

a. Minor leaks do to "O" ring failure or corrosion around mechanical, electrical, and pipe hull penetration.

b. External depth gage leaks due to gage failure.

c. Pneumatic lines leaks allowing water to back up line into J-S-L I compartment.

d. Electrical penetrator burn out.

Any one of the above is cause to abort a mission. Surface as soon as possible. Pressurization of the sphere to control these leaks should not be done except when on the surface. The sphere hatch will only hold 60 PSI of internal differential pressure. Electrical equipment should be secured as necessary to eliminate short circuits.

Fire

1. The most probable cause of a fire in the J-S-L I will be an over-loaded circuit due to a ground or a faulty electronic component. Prior to the fire the submersible occupants are likely to detect an odor of smoldering insulation and/or possibly see smoke. Just prior to this or maybe simultaneously the occupants should note the failure of a piece of equipment. The second most probable cause of a fire would be due to auto-ignition in one of the pneumatic systems. Because fire cannot be entirely ruled out, oxygen should be carefully monitored to eliminate concentration above twenty-one per cent. The lowest concentration of oxygen capable of supporting life without any ill effects is eighteen per cent.

2. Smoke and/or fire while cruising

   a. In the sphere

      (1) Turn off circuit breakers.

      (2) Turn off sphere 0_2 flow.

      (3) Don emergency regulators and face masks.

      (4) Fight fire with extinguisher and/or water.

      (5) Commence surfacing.

      (6) Inform the support ship and diver compartment.

      (7) Upon reaching the surface, ventilate with H_e0_2; through the flare gun barrel as necessary.

b. In the diver compartment

(1) Secure the O_2 bleed.

(2) Inform the sphere.

(3) Don emergency regulators and face masks or Kirby Morgan masks.

(4) Fight fire with extinguishers and/or water.

(5) Sphere:

(a) Secure diver power and oxygen to the diver compartment.

(b) Commence surfacing.

(c) Inform the support ship.

(d) When the J-S-L I reaches the surface have the divers ventilate the diver compartment with H_eO_2.

3. Smoke and/or fire while a diver is locked-out:

a. In the sphere:

(1) Secure the oxygen bleed.

(2) Call the diver back.

(3) Turn off circuit breakers.

(4) Don emergency regulators and face masks.

(5) Fight fire with extinguishers and/or water.

(6) Man the sound powered phone.

(7) Commence surfacing as soon as the diver compartment is over pressurized.

(8)o Inform the support ship if possible.o

(9)o Upon reaching the surface ventilate witho H_eO_2 through the flare gun barrel.o

b.o In the diver compartmento

(1)o Inform the sphere.o

(2) Don emergency regulator or spare Kirbyo Morgan mask and enter the water in theo manway.o

(3) Fight the fire with water or extinguisher.o

(4)o Blow down with H_eO_2.o

(5)o Sphere:o

(a)o Alert the diver in the water.o

(b)o Secure oxygen to diver compartment.o

(c)o Inform the support ship.o

(d)o If smoke cannot be cleared byo ventilating, flood the diver compartmento and then blow down.o

(e)o As soon as the smoke is cleared geto the divers back inside and commenceo surfacing.o

Ruptured Pressure Line

1. Internal - A ruptured pressure line or leaking fitting on any one of the pneumatic systems inside the submersible can easily be detected by the sudden change in the noise level and/or the increase in compartment pressure. A leak in the oxygen system can also be detected by monitoring the PO_2 meters. The faulty system should be isolated immediately by securing the appropriate hull stop valve. In most cases it will be possible to by-pass or repair the malfunction while submerged. A report should be passed to the support ship.

2. External -

   a. Vent control lines - In the event that one of the vent control lines ruptures or has a fitting work loose it is possible to have sea water back up the line and leak out the vent hole in the vent control valve if it is in the closed position. This problem can be isolated immediately by securing the appropriate hull stop valve. A report should be passed to the support ship.

b. Ballast tank pressurization lines - A ruptured or leaking ballast tank pressurization line would be detected by observing bubbles while pressurizing the ballast tank. Since the variable ballast tanks have a common pressurization line, a break in this line would disable both. All other ballast tanks have separate pressurization lines and a broken line can easily be isolated by securing the appropriate blow valve. The main ballast tanks also have separate pressurization lines running from the diver compartment, so if one of the primary pressurization lines from the sphere has to be isolated, that tank can still be pressurized from the diver compartment. The mission should normally be aborted and the pilot should request permission to surface as soon as practicable after detecting a faulty ballast tank pressurization line.

c. Gas supply lines - A rupture in one of the gas supply lines will be detected by loss of pressure on the appropriate gage and/or bubbles in the water. In the event a gas supply line is broken, secure the appropriate hull stop valve and realign valves as necessary to keep the J-S-L I operational. Request permission to surface as soon as practicable.

Loss of Power

During a mission the main circuit breakers may trip due to an overload. When this happens all equipment should be de-energized and the breakers reset. Then energize the equipment again, one piece at a time, to attempt to establish the cause. If the breakers continue to trip and the cause cannot be isolated, surface with caution as soon as practicable.

Entrapment

1. Your best insurance for survival in case of entrapment is the pre-mission planning and the thoroughness with which the pre-launch check was made; one item overlooked could make the difference between life and death.

2. Entrapment of J-S-L I means that it is being physically held in place, such as getting caught in a crevasse, being stuck in the mud, entangled in plant life, or entangled in submerged debris, such as cables or fish nets. More than likely the J-S-L I could be worked out of all these situations by using the thrusters and blowing all ballast tanks, except entanglement in submerged debris.

3. As long as either the diver compartment or pilot's sphere is dry, the J-S-L I has enough positive buoyancy to surface if it is not anchored to the bottom in some way. If, by chance, the diver compartment was flooded, the battery pod would have to be dropped and the main ballast tanks blown to gain enough positive buoyancy to surface.

4.e If the J-S-L I is entrapped and cannot gain it'se freedom by blowing all ballast and thrustering, time should not be wasted waiting on help from the surface. Turn off all unnecessary electrical equipment to conserve power for your scrubbers and communications. Vent off ballast tank, blow down and diver compartment and lock-out a diver to survey the situation. Once you know what your problem is you can figure a way out. This information will be invaluable to the people on the surface preparing for your rescue. Be sure to keep accurate records on the divers' depth and time. Keep the support ship informed of all measures taken.

5.e In the event that J-S-L I divers are unable toe free the J-S-L I, bring them back in and shute both "A" and "B" hatches. Do not over pressurize. Release your emergency location buoy, keep calm, conserve power, monitor your PO_2 and PCO_2 meters, and maintain communication on the sound powered phone.

<u>NOTE:</u> Anytime the J-S-L I is launched it has gas onboard for a lock-out to maximum mission depth plus adequate dive gear and rescue tools aboard. There is always at least one qualified J-S-L I lock-out diver in the diver compartment.

Emergency Buoy

A. Purpose

To mark the location of the J-S-L I and provide a means of rescue.

B. Reference Documents

1. Figure 1.4 and 1.5, J-S-L I Pictorial Views
2. Appendix "D", J-S-L I Drawing Index

C. Specifications

1. Buoy
   a. Polyform inflatable
   b. 4.4 cu. ft.
   c. 281 pounds positive buoyancy
2. Cable
   a. Phillystran .19"
   b. 2000'
   c. 5500 pounds breaking strength
   d. Will stretch 4% before breaking

D. Description and Operation

A 2000-foot reel of .19 inch Phillystran cable is mounted on the inboard side of the starboard main ballast tank between the pilot's sphere and the diver compartment. This cable is threaded up through an aluminum funnel that has been flattened so that it is longer than it is wide. The cable is attached to a 4.4 cu. ft. Polyform inflatable float that contains a quart of mineral oil as a lubricant and has been deflated with a vacuum pump, rolled up and tied into the aluminum funnel. This funnel also acts as a receptacle for the surface rescue drop-lock. The float is equipped with a 2 PSI relief valve. High pressure air is piped up from the pilot's sphere to a special adaptor that is attached to the funnel and the float. When the float is pressurized from the sphere it expands and breaks away from the funnel and air connection. Fully inflated, the buoy has 281 pounds of positive buoyancy which overcomes the tension on the reel of the cable and streams it to the surface.

E. Rescue

Submersible rescue can be accomplished by dropping a specially designed drop-lock down the buoy line. The drop-lock is grooved on one side so the unit fits around the buoy line. The end is attached to 1500 ft. of rescue cable. The rescue winch is located on the submersible's support vessel.

DDC Facility

The following is a detailed breakdown of the D.D.C. volumes and gas storage capacities:

Entrance Lock	= 67.9 S.C.F.
Main Lock	=127.9 S.C.F.
Transfer Trunk	= 26.0 S.C.F.
Medical Lock	= 1.5 S.C.F.

PSI Rating 350 psi = 785 F.S.W.

E.L. at 785 F.S.W. =	1683 S.C.F.
M.L. at 785 F.S.W. =	3170 S.C.F.
T.T. at 785 F.S.W. =	644 S.C.F.
TOTAL	5497 S.C.F. = 53.9% of R/V JOHNSON Heliox Banks or a Reserve Capacity of 4703 S.C.F.

H_e/H_eO_2 Bank	Cu. Ft.	
1	1200	
2	1200	
3	900	
4	900	
5	1200	
6	1200	
7	1500	
8	1200	
*9	900	(H_e for Fire System Pressure in D.D.C.)
10	900	
	10,200	cu. ft. (*not counting #9)

Oxygen = 2100 cu. ft.
Air = 2400 cu. ft.

.8 ATM O_2 = 3.23% mix at 785 F.S.W.

3.23% of 5497 S.C.F. required to blow M.L., E.L., and T.T. to 785 F.S.W. = 177.5 S.C.F. O_2. 177.5 S.C.F O_2 = 8.45% of R/V JOHNSON O_2 capacity.

If J-S-L is filled to capacity with proper mix for diver and R/V JOHNSON is also filled to capacity we would theoretically have 46.1% of ships HeO_2 capacity as reserve gas available for the entire D.D.C. complex. Oxygen does not present a problem until oxygen decompression is needed.

For example:

at 60 ft. with two divers breathing 3/4 cu. ft./min. of O_2 (each) = 1.5 cu. ft./min. x 2.8181 ATM = 4.23 cu. ft./min. or 253.6 cu. ft. O_2/hr.

For example:

At 30 ft. O_2 consumption would be 171.8 cu. ft./hr.

Total O_2 capacity of R/V J = 2100 cu. ft. O_2

The D.D.C. facility aboard R/V JOHNSON is a closed circuit system with full instrumentation to monitor and control life support. Environmental control equipment include the following:

1. Beckman CO_2 Analyzer
2. Lindbergh Hammar CO_2 Scrubber
3. Bio Marine O_2 Analyzer Recorder
4. Pyrotector Automated Fire Suppression System
5. Helle Communications
6. Lighting via External Source
7. Remote Temperature Proble
8. Scott Oxygen Breathing Regulators with Overboard Dump

Other equipment which enhance the safety of the entire complex or which are back-up equipment are the following:

1. Bio Marine Hand O_2 Analyzers (3)
2. Bio Marine Explosive Gas Monitor
3. Remote O_2 Emergency Shut-off
4. 12, 24 and 36 V.D.C. Electrical System
5. Open-mike land phone (when in Link Port)

PRIMARY LIFE SUPPORT EQUIPMENT

1. Beckman CO_2 Analyzer (see Reference 1)
2. Lindbergh Hammar Scrubber
   Sodasorb is used in these units and can either be filled within the chamber or a fresh canister can be sent in via the medical lock. See Reference 2 for further information on the performance.
3. Bio Marine O_2 Analyzer Recorder
   This unit will simultaneously measure the PO_2 in the main lock and entrance lock as well as the ship's lazarette and control console. Rustrak recorders continuously operate for the main lock and entrance lock only. The chamber stations read from 0 - 2.0 ATM of O_2 and the lazarette and control console stations read from 0 - 0.4 ATM of O_2. For further information, see Reference 3.
4. Pyrotector Automated Fire Suppression System
   This integral system utilizes Helon 1301 in the control console and lazarette and water with a helium pressure head for the main lock and entrance lock. Operation of the system is either manual or automatic utilizing numerous infra-red sensors to activate the system. For further information on this system, see Reference 4.

5. Helle Communications
This system provides communication via speakers to the main lock and entrance lock. To date no provisions have been made for helium voice unscrambling. Communications are continuously open from the chambers to the control console.
6. Lighting via External Source
Light to the main lock and entrance lock is provided via J. M. Canty Associates rheostated lights mounted externally. Light enters the chambers via plexiglass penetrators.
7. Remote Temperature Probe
Continuous monitoring of the temperature in the main lock in degrees F is shown in the control console on a Weksler Instrument Gauge.
8. Scott Breathing Regulators with Overboard Dump
There are two regulators in the main lock and one regulator in the entrance lock. All regulators have a first stage regulator mounted internally to provide 125 psi over ambient to the divers. All masks are also equipped with a vacuum regulator so that divers may use them as emergency breathing regulators at any depth. These same masks provide either air, mix-gas or oxygen to the divers upon demand.

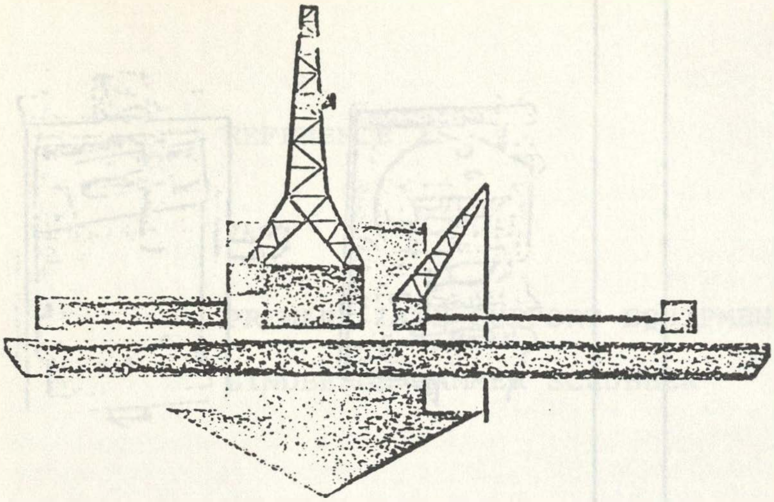
BACK-UP EQUIPMENT

1. Bio Marine Hand-Held O_2 Analyzers
Three model 255 Bio Marine O_2 Analyzers are available in the control console with the following scales: 0 - 100%, 0 - 25%, 0 - 10% and 0 - 5%. One unit is semi-permanently attached to the sample line from the main lock and entrance lock. For further information on this unit, see Reference 5.
2. Bio Marine Explosive Gas Monitor
This unit continuously monitors for the presence of any flammable or explosive gas in the lazarette. For further information, see Reference 6.
3. Remote O_2 Emergency Shut-off
In the event of fire or catastrophic leak in the oxygen system the O_2 bottles can be secured at the bottles via a remote valve in the control console area. This is done utilizing pneumatic shut-off valves. These valves must be turned on topside prior to each operation.
4. 12, 24 and 36 V.D.C. Electrical System
Every essential life support system is run on D.C. current so that in the event of malfunction or temporary shut-down of the ship's 110 and 220 V.A.C. system, all functions will continue normally. The only equipment which will not run on A.C. is the internal lighting in the chambers and the Rustrak recorders in the O_2 monitoring station.
5. Open-mike Land Phone
When the ship is in Link Port there is a telephone in the control console area which can be operated "no hands".

REFERENCE I

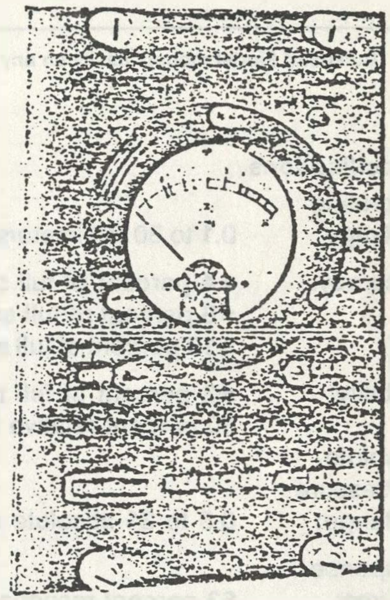
PRIMARY LIFE SUPPORT EQUIPMENT

BECKMAN CO_2 ANALYZER



Beckman MINOS®

Atmospheric Carbon Dioxide Monitor



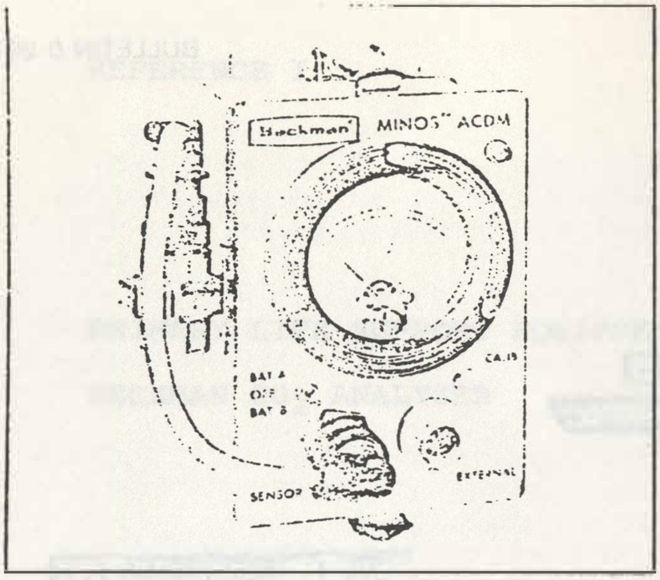
General Description
Designed for the rugged hyperbaric environments of diving, clinical, and research chambers, the MINOS ACDM (Atmospheric Carbon Dioxide Monitor) will faithfully safeguard your breathing environment by measuring carbon dioxide content from 0.1 through 30 millimeters of mercury partial pressure. Although the availability of oxygen at safe levels in a sealed chamber is critical, the build-up of carbon dioxide must also be monitored carefully. The MINOS ACDM helps to make certain that personnel inside chambers are not exposed to dangerous levels of carbon dioxide. The MINOS ACDM—together with its companion MINOS AOM (Atmospheric Oxygen Monitor)—offers you a *complete* atmospheric monitoring system.

Superior Design Sensing System
This self-contained system responds directly to the partial pressure of carbon dioxide, independent of total sample pressure. Operating electro-chemically, the sensor contains a pH electrode and a reference electrode. Separated from the atmosphere by a membrane permeable to carbon dioxide, the electrolyte pH will change as a function of exposure to carbon dioxide. Electrode potential is proportional to a logarithm of the partial pressure of carbon dioxide in the sample. The partial pressure of carbon dioxide is displayed on a logarithmic meter scale on the instrument. The ACDM may be ordered for either panel or bulkhead mounting.

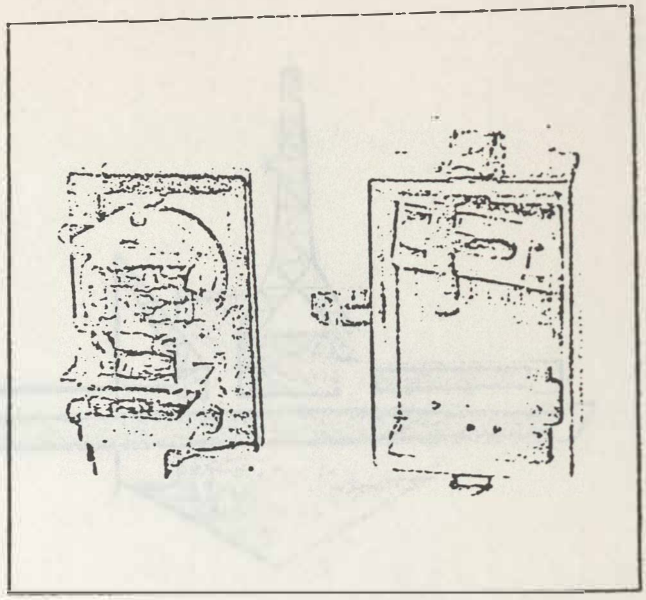
The rechargeable sensor will operate up to 30 days before recharging is necessary. Since the sensor receptacle contains a preamplifier, the sensor can be used at considerable distances from the meter, with no signal degradation from cable noise; or, if desired, the sensor-receptacle assembly is easily mounted directly on the face of the instrument. The ACDM functions in operating pressures as high as 35 absolute atmospheres, making it ideal for almost any application from ambient to hyperbaric pressure.

Features
- Uses alkaline batteries or 12 to 32 VDC external power (some options require 14 to 32 VDC external power).
- External outputs available for remote alarms, meters, recorders, or an analog-to-digital converter.

Complete Monitoring Systems
By using the MINOS ACDM in conjunction with the MINOS AOM (Atmospheric Oxygen Monitor), a complete atmosphere monitoring system is established. Ask for Bulletin 0-2016 for information on the MINOS AOM.



Bulkhead Model mounts easily on any vertical surface.



Compact and self-contained, ACDM is all-solid-state.

Specifications

Operating Range:	0.1 to 30 millimeters of mercury, P_{CO_2}.
Accuracy:	±4 percent of full scale, 60 to 90°F. ±8 percent of full scale, 40 to 110°F; ±10 percent of full scale, 35 to 130°F.
Stability:	±3 percent of full scale, 30 days, at 80 percent relative humidity.
Absolute Pressure Range:	0.5 to 35 absolute atmospheres.
Response Time:	63 percent response to step function increase in sample partial pressure to 25 mmHg, P_{CO_2}, or more within one minute.
Relative Humidity:	To 100 percent.
Outputs:	0 to 2.5 Vdc with 25K minimum load; 0 to 50 mVdc at 500 ohms; 0 to 100 μA; all outputs double-ended.
Options:	For alarm and control options, see price list for Bulletin 0-2018.
Power:	12 to 32 Vdc external source or internal batteries (Mallory MN 1604 alkaline cell); 14 to 32 Vdc external power for alarm and control options.
Size:	Bulkhead Mount, 6¼ x 4¼ x 3½ inches; Panel Mount, 7½ x 5 x 5 inches.
Weight:	Bulkhead Mount, 5¾ pounds; Panel Mount 4½ pounds.

Beckman INSTRUMENTS, INC.
OCEANIC EQUIPMENT ACTIVITY
441 PETERS ROAD, HARVEY, LOUISIANA 70058
2500 HARBOR BOULEVARD, FULLERTON, CALIFORNIA 92634
LOUISIANA (504) 358-6272 • CALIFORNIA (714) 871-4848

071814.571-51P

PRINTED IN U.S.A.

REFERENCE 2

PRIMARY LIFE SUPPORT EQUIPMENT

LINDBERGH HAMMER SCRUBBER

LINDBERGH-HAMMAR ASSOCIATES
~~559 Maple Avenue, Carpinteria, California 93013~~
~~Telephone: (805) 684-4319~~
5511-A EKWILL ST.
SANTA BARBARA, CALIF 93111
(805) 964-1230
2329

JON M. LINDBERGH
Consultant
JAMES H. HAMMAR
Development & Engineering
ROBERT A. BAKER
Administrative

THEORY OF OPERATION
PURA 787M CARBON DIOXIDE REMOVAL SYSTEMS

Units in this series are assembled from three main components; an outer sealed case, a refillable dessicant canister, and a power unit. The canister and power unit are mounted in tandem within the exterior case. In operation the turbine end of the power unit exhausts air from inside the case, forcing it out through coaxial ducting surrounding the power unit. As the gas within the case is exhausted, a pressure differential is established, causing external air to flow through the intake end of the dessicant canister. This air is scrubbed or purified by chemical compounds which retrieve and retain carbon dioxide, and pass other gases in the breathing mixture to be reused indefinitely.

Operating electric motors of any type in environments with high partial pressures of oxygen or flammable gases is extremely hazardous. Commutator-type motors with sparking brushes are obviously dangerous. Induction motors, though brushless, are also dangerous since short circuits can develop in field and rotor coils to trigger an explosion. Inverter-type motors share the same deficiencies.

The PURA 787M completely isolates the motor, wiring system and other electrical components from contact with the environmental atmosphere by installing these inside a heavy walled pressure vessel. To eliminate the danger of seal wear on a rotating motor shaft, a magnetic coupling connects the motor with the external dual turbine. There is no direct mechanical connection between motor and turbine; magnetic lines of forcee pass through solid stainless steel, establishing a high torque interlock. All dynamic sealing is eliminated. Other static sealed closures are dual sealed with two types of O-ring glands for safety. Each unit is environmentally leak checked at pressure stages from 1 to 1500 PSIG and certified.

Motor heat is dissipated through a heat sink system. There is no direct air flow through the motor.

All bearings in contact with high pressure environmental oxygen are specially treated and compatible with any breathing mixtures.

ELECTRICAL CONNECTIONS - 787M9 Series scrubbers operate on 24 to 60 volts, AC or DC. The motor is a universal type and is uni-directional; it cannot be externally reversed by interchanging leads. Connect two wires from hull penetrator to a suitable power source. Make certain that all connections are mechanically tight. Tie down all loose cable with suitable straps or clamps to guard against accidental snagging. Use only approved explosion-proof switches in pressurized environments. DO NOT make or break pressure-exposed connections in oxygen atmospheres.

GROUND TERMINAL - Secure a heavy gauge wire to the ground terminal (located at the exhaust end of the unit next to the hull penetrator) and connect it to an adequate ground; (metal sidewall of a hyperbaric chamber). CONNECT GROUND CABLE BEFORE OPERATING UNIT.

MOUNTING- Scrubbers will operate in any attitude. Preferred mounting position is vertical, against a sidewall near floor level. (See Loading) Any holes drilled and tapped into the scrubber end plates for mounting purposes should be sealed gas-tight with RTV Silicone Cement. (See Punctures) Special mounting brackets are available from the factory.

SNAP-LOCKS - The quick-release hooks securing the loading cover penetrate the case through O-ring gland fittings and are gas-tight. Apply a drop of APPROVED SILICONE OIL to each rod to keep it operating smoothly. (See Lubrication and Loading)

FITTINGS and HARDWARE - All stock fittings have been tested and certified. Do not endanger safety and certification by changing or altering installed fittings. If modifications are required, return to factory for refitting, testing and certification. (See Maintenance) DO NOT DRILL, TAP WELD, OR IN ANY WAY ALTER THE PRESSURE HOUSING.

ABSORBENT - Any approved carbon dioxide absorbent may be used, including plastic prepacks (disposable type). Prepacks are NOT recommended in high partial-pressure oxygen atmospheres because of their flammability. Gas flow through prepacks is not as efficient as through stock stainless steel refillable canister. (See Loading and Baralyme/Sodasorb : pH)

CO_2 REMOVAL - Gas exchange rate is controlled directly by varying input voltage. Unit can be ideally matched to any system by monitoring CO_2 level and altering the supplied voltage. In large hyperbaric installations, multiple scrubbers may be used to hold CO_2 concentration at the required level. (See excerpts - test reports)

PAINT - Use only fire-resistant, oxygen-compatible epoxy coatings when retouching any surface.

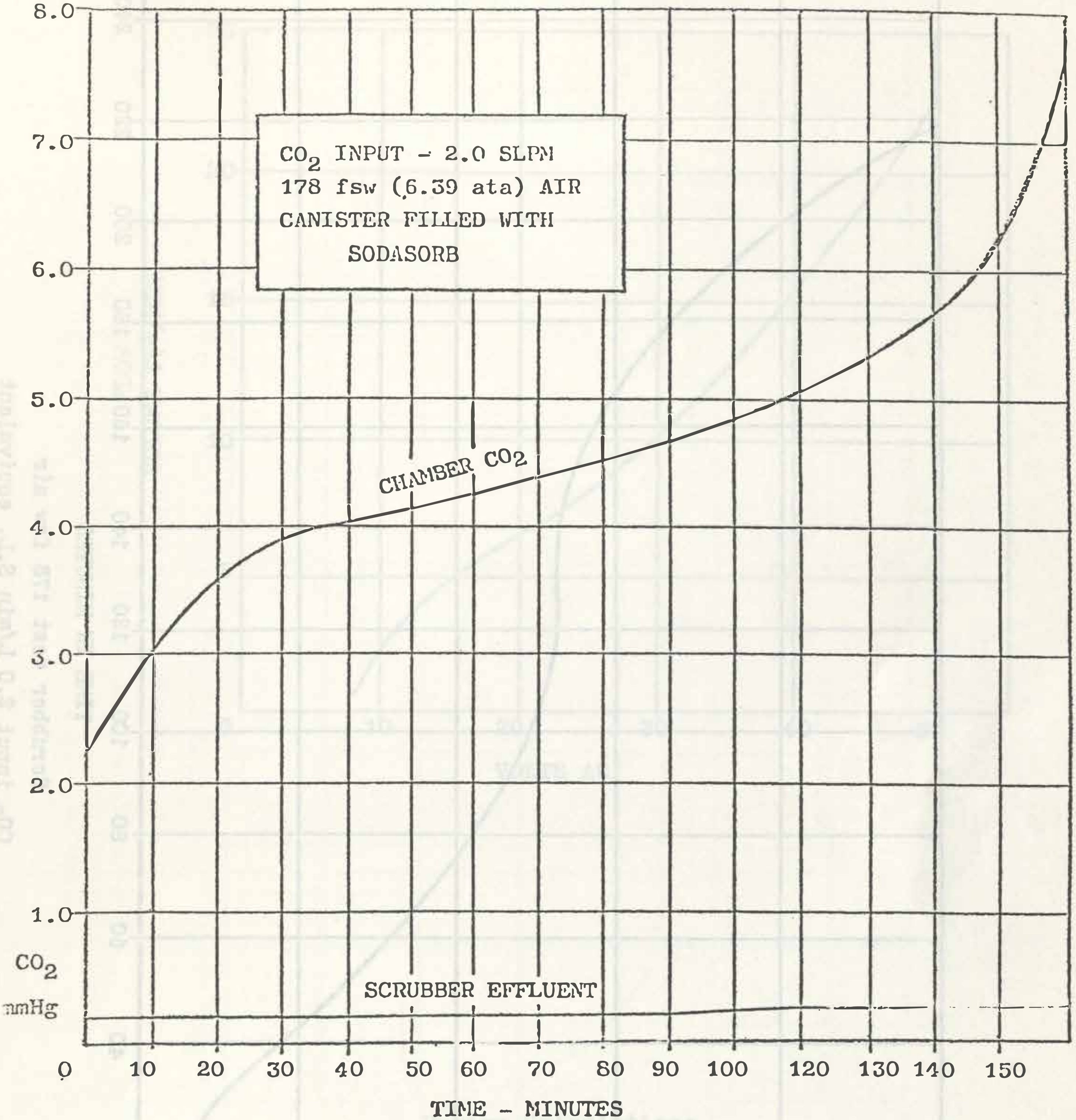
LOADING - The unit is prepared for use by filling the desiccant canister with a carbon dioxide absorbent chemical. Fill prior to each use with fresh, dry desiccant. DO NOT OMIT this procedure. Sodasorb is recommended, although the canister may be charged with any approved desiccant.

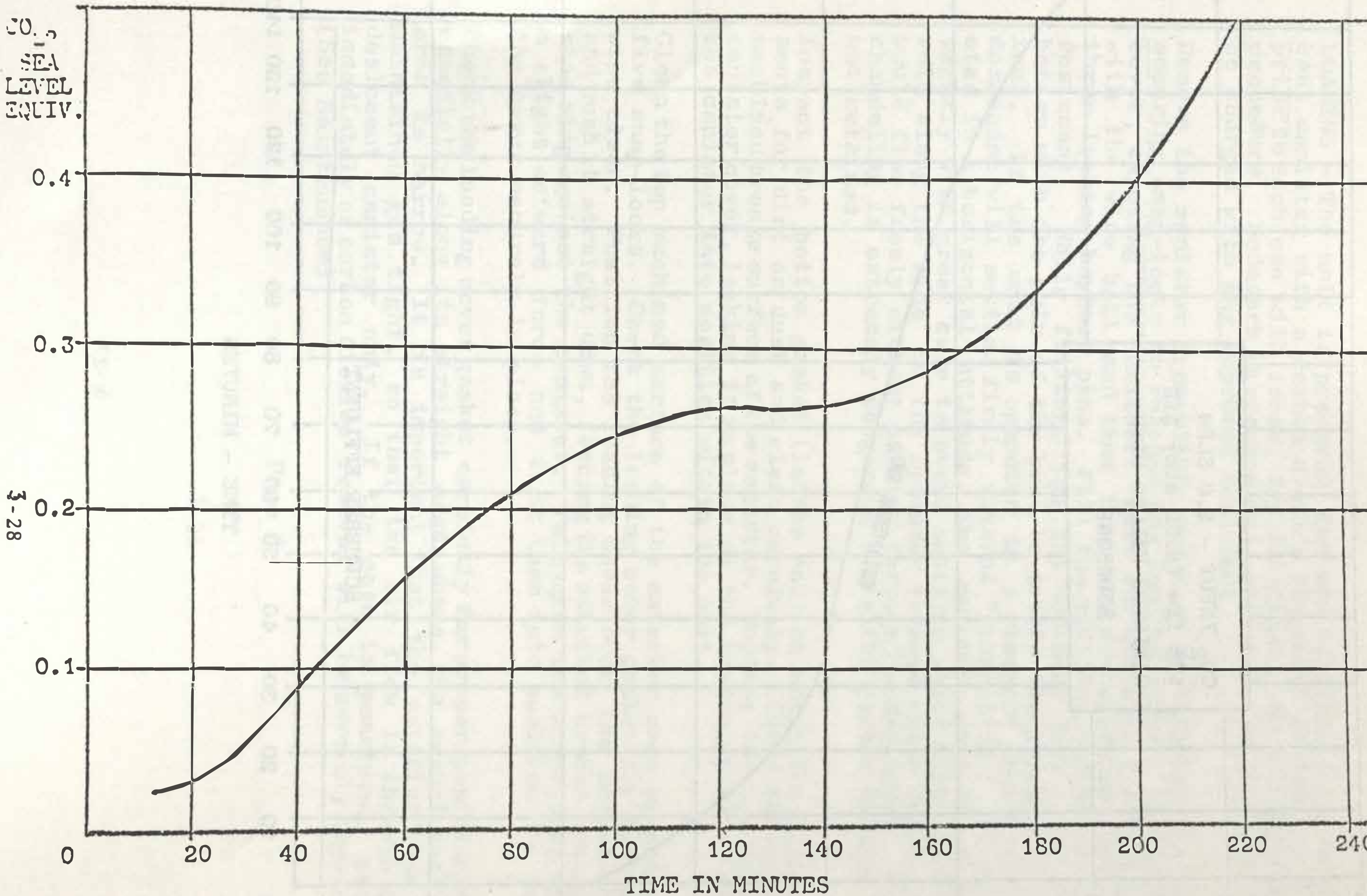
Remove the canister from within the case by twisting the five securing snap-locks to release the loading cover. Remove the cover, exposing the canister. Lift the canister straight out with the wire bail and then free the canister top from the three locking bayonet pins. Fill the cylinder carefully with desiccant. While filling, tap the canister firmly on the bottom with the palm of the hand to settle the granular chemical. If the unit is operated in a vertical position, the desiccant will settle firmly without "channeling." If operated in a horizontal attitude, the canister must be packed tightly with great care to avoid settling which might cause a void along the side of the cylinder through which intake gas would flow freely without passing through the desiccant. Such channeling is extremely dangerous since the carbon dioxide is not retained.

Inspect the bottom gasket (intake end) on which the canister seats for dirt or dust and clean carefully. Clean the mating machined bronze surface of the canister. Replace the top screen canister cover, locking it in place on the bayonet pins. Lower the canister into position within the unit.

Clean the top machined surface of the exterior case around the five snap-locks. Check the loading cover gasket for dust and wipe clean. Position the loading cover over the snap-locks, and push it straight down, forcing the attached bronze compression ring against the canister. Pull up on the snap-locks with a slight outward force and twist them into position to lock the cover securely in place.

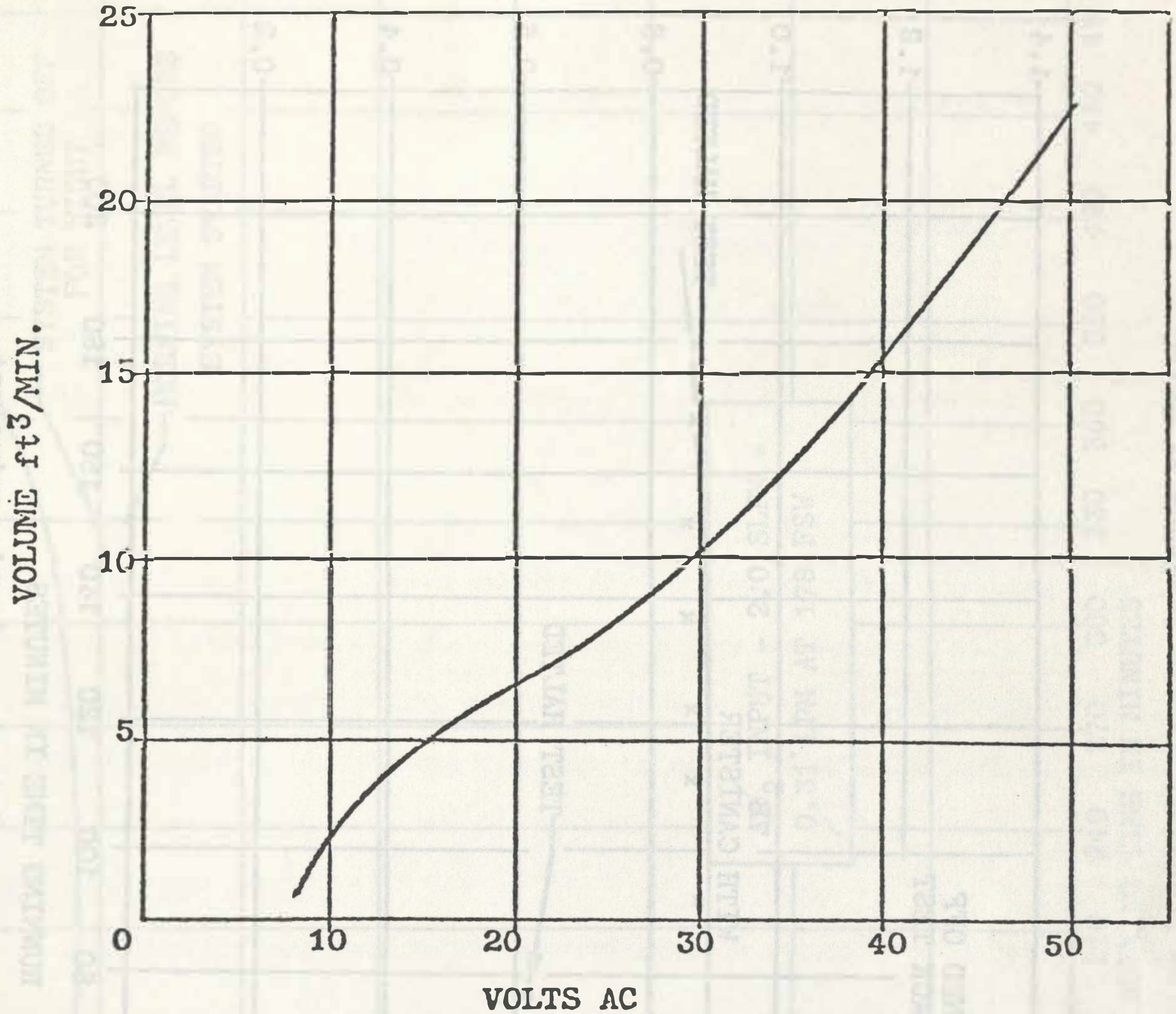
Check the loading cover gasket carefully for proper positioning, especially along its straight edge where the actual sealing area is narrow. It is important that the exterior case is maintained gas tight, so that the air flow is through the desiccant canister only. If the case is punctured, patch immediately or carbon dioxide removal will be severely impaired (See Maintenance)


CO2 INPUT - 2.0 SLPM
178 fsw (6.39 ata) AIR
CANISTER FILLED WITH
SODASORB
CHAMBER CO2
SCRUBBER EFFLUENT
CO2
mmHg
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0
10
20
30
40
50
60
70
80
90
100
120
130
140
150
TIME - MINUTES

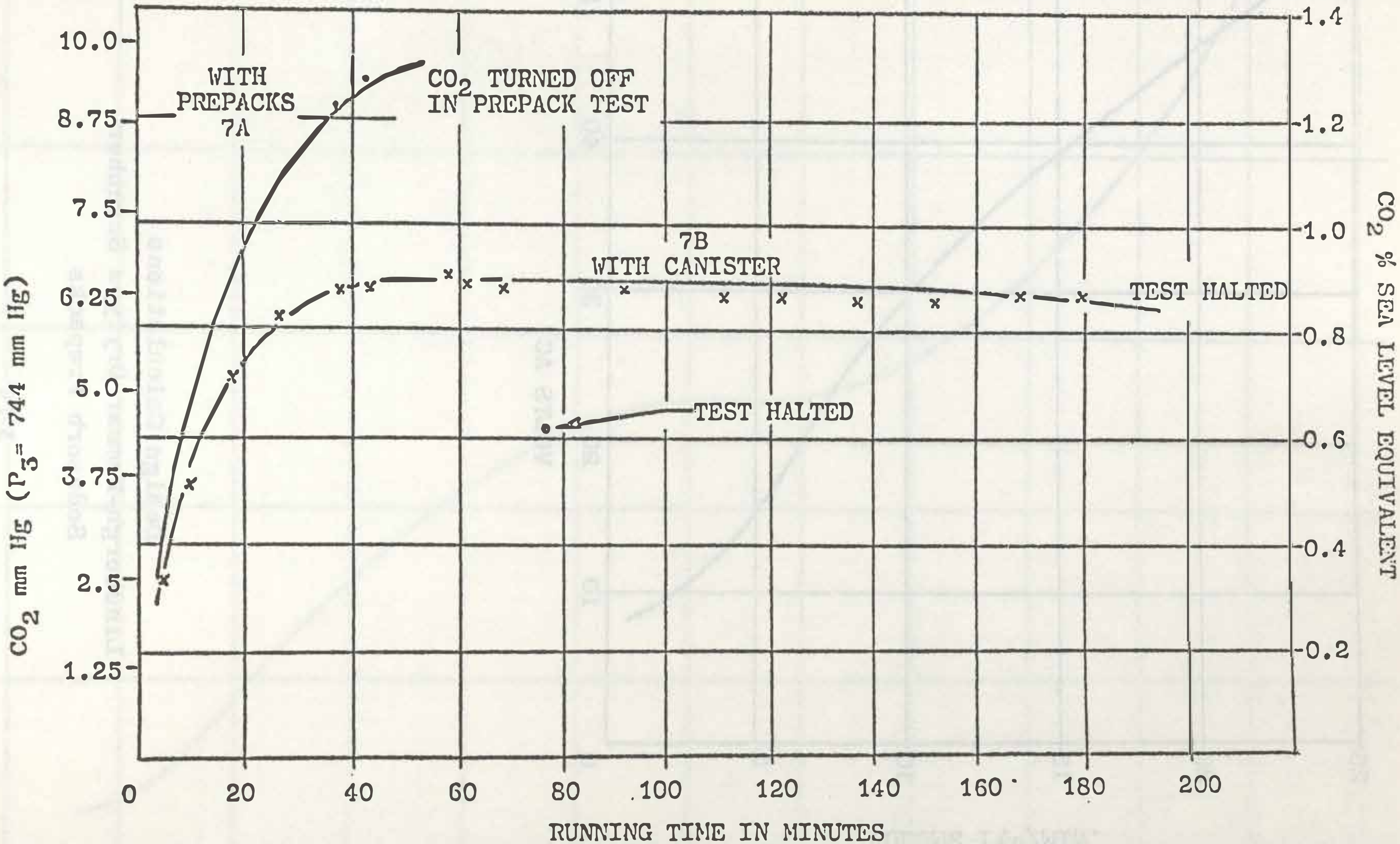


Scrubber test 178 fsw air

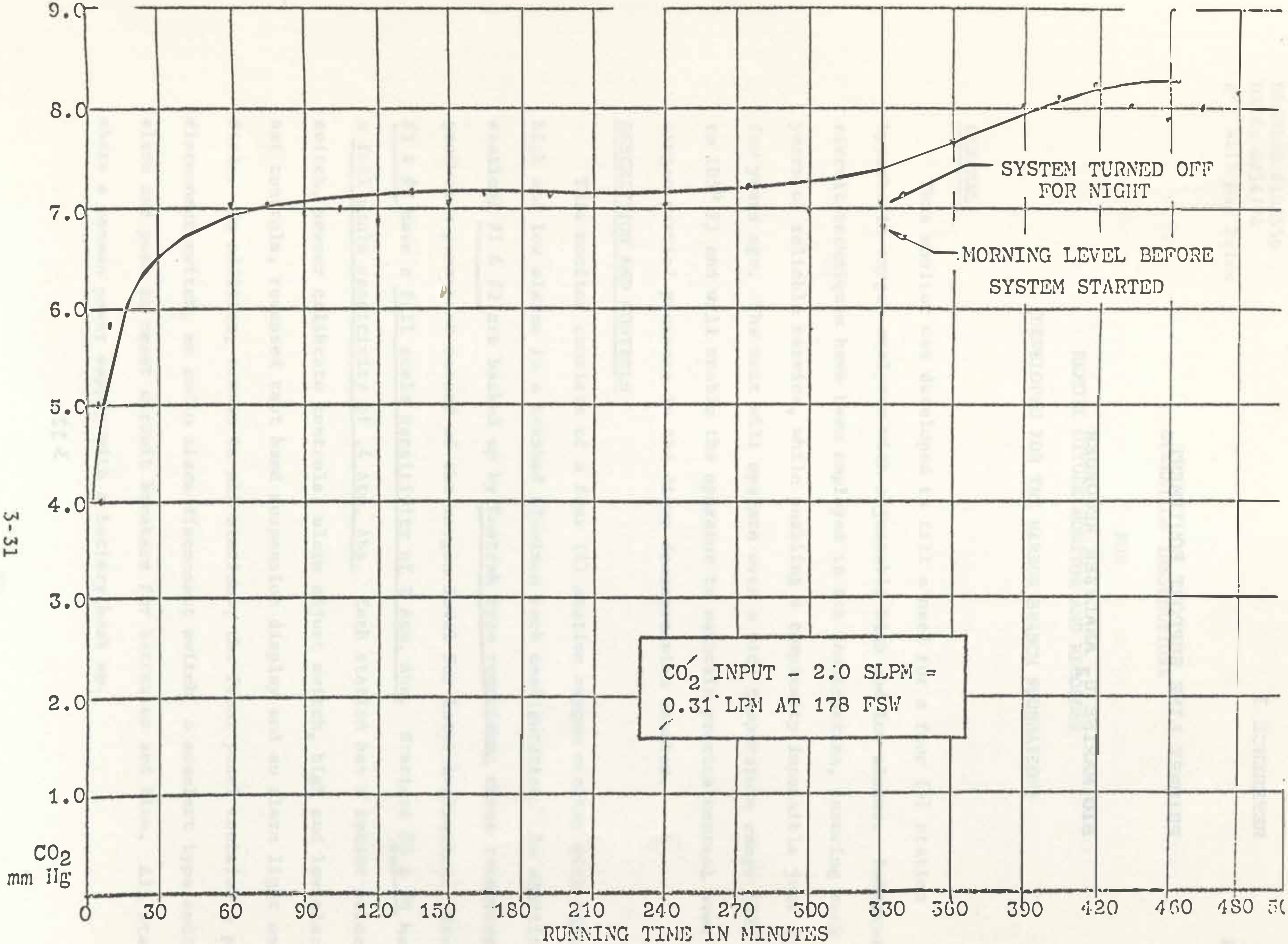
CO_2 input 2.0 L/min S.L. equivalent



Design Calculations
Lindbergh-Hammar Drytype Scrubber
Sodasorb Prepacks



Chamber CO_2 in mmHg and in % sea level equivalent
Lindbergh-Hammar Scrubber, 24 VAC prepacks of Sodasorb vs. canister of Baralyme; CO_2 input : 2.0 SLPM at 178 fsw air



Chamber CO_2 Using Lindbergh-Hammar Scrubber at 24VAC with Sodasorb packed in a cartridge at 178 fsw on air

REFERENCE 3

PRIMARY LIFE SUPPORT EQUIPMENT

BIO MARINE O_2 ANALYZER RECORDER

DRAWING #10A556
DATE: 8/14/74
BY: Bill Mac Bride

OPERATION INSTRUCTIONS

FOR

REMOTE OXYGEN MONITOR AND RECORDER

(DEVELOPED FOR THE HARBOR BRANCH FOUNDATION)

GENERAL

This monitor was developed to fill a need for a four (4) station hyperbaric oxygen analyzer with adjustable high and low alarms. Integrated circuit techniques have been employed in its construction, insuring many years of reliable service, while enabling a complexity impossible just a few years ago. The unit will operate over a wide temperature range (32^{o} F to 105^{o} F) and will enable the operator to maintain precise control over the oxygen partial pressure in the diver decompression chamber.

DESCRIPTION AND CONTROLS

This monitor consists of a four (4) station oxygen monitor with adjustable high and low alarms in a brushed aluminum rack configuration. In addition, stations #1 & #2 are backed up by Rustrak type recorders; these recorders produce a permanent record of the oxygen level for later evaluation. Stations #1 & #2 have a full scale sensitivity of 2 Atm. Abs. Stations #3 & #4 have a full scale sensitivity of .4 Atm. Abs. Each station has a sensor select switch, sensor calibrate controls, alarm adjust switch, high and low alarm set controls, recessed taut band suspension display and an alarm light emiting diode. In addition, common to all stations, the front panel contains a power disconnect switch, an audio alarm disconnect switch, a sonalert type audio alarm and push to reset circuit breakers for batteries and line. All stations share a common power supply with a battery back up.

REFERENCE 4

PRIMARY LIFE SUPPORT EQUIPMENT

PYROTECTOR AUTOMATED FIRE SUPPRESSION SYSTEM

SECTION 1

DESCRIPTION

1.1 INTRODUCTION

This technical manual provides information on the Optical Fire Detection and Extinguishing System Components manufactured by Pyrotector, Incorporated, Hingham, Massachusetts for installation in HBF's shipboard decompression facility.

1.2 GENERAL DESCRIPTION

The Fire Detection and Extinguishing System is an integrated automatic detection, warning and extinguishing system utilizing high speed optical detectors, signal conditioning amplifiers, control panel and Halon 1301 extinguisher assemblies which can be activated at the control panel by operation of electrical switches or manually at the site of the solenoid valve assembly. Remote manual operation may be incorporated by the addition of pull cables connected to the manual override lever on the solenoid valve assembly.

Independent detection and extinguishing is provided for the lazarette, control console area and D.D.C. A separate control amplifier is mounted in or adjacent to each compartment to accept detector signal inputs and to relay alarm output to the control panel.

Pressure Switches are installed in each Compartment. They turn on an amber light on the control panel and are activated by the pressure rise in the extinguishing agent distribution piping when the system is discharged.

Audible alarms (Horns) are located in the D.D.C. control console to warn of a fire in any compartment and in the control console to warn of a fire in that compartment.

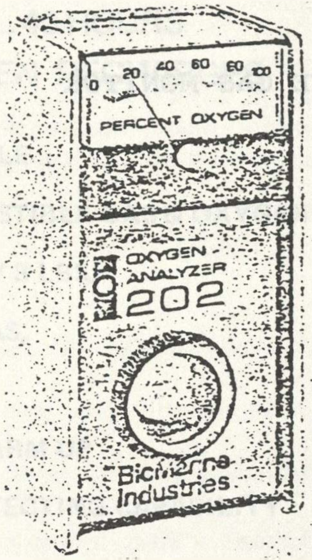
A test switch is provided on the electrical control panel for verifying system integrity and operation of the detection components. Components of the system are designed to operate from a nominal 28 VDC. Compartments protected by the system and allocation of components are listed in Tabele 1-1. Descriptions and illustrations of components are provided in Figures 1-1 through 1-10.

REFERENCE 5

BACK-UP EQUIPMENT

BIO MARINE HAND HELD O_2 ANALYZERS

BioMarine Industries



OA 200 SERIES operating instructions

Oxygen Analyzers

GENERAL

BioMarine analyzers provide continuous direct reading of the oxygen concentration in any given environment. Easily portable and simple to operate, the analyzers are automatically temperature compensated over their full operating range of 32°F to 104°F (Model OA222, 45°F to 104°F) require single point calibration and perform accurately in high humidity environments.

REFERENCE 6

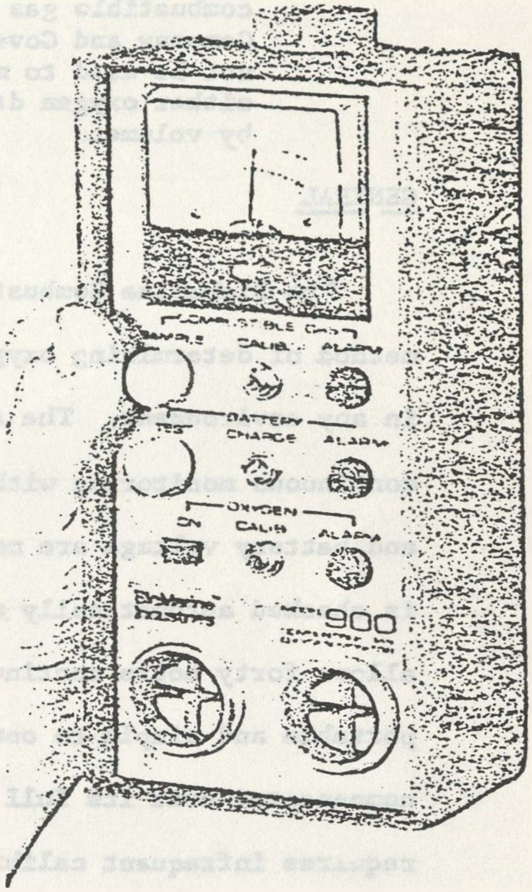
BACK-UP EQUIPMENT

BIO MARINE EXPLOSIVE GAS MONITOR

MODEL 900 BioMarine Industries

COMBINATION COMBUSTIBLE GAS/OXYGEN DETECTOR WITH ALARMS . . . . 40 HOURS CONTINUOUS USE BETWEEN RECHARGES

- HAND HELD - TRULY PORTABLE
- BUILT-IN ALARM FOR COMBUSTIBLE GAS & OXYGEN
- LIGHTWEIGHT - WEIGHT ONLY 3 LBS.
- 0 - 100 LEL COMBUSTIBLE GAS,
  0 - 40% OXYGEN SCALE
  0 - 5% METHANE
- IMMEDIATE READING - NO WARM UP
- DIFFUSION AND REMOTE DETECTING CAPABILITY
- INTRINSICALLY SAFE
- COMPLETE WITH CARRYING CASE AND SAMPLING KIT



The Model 900 provides continuous monitoring of both combustible gas and oxygen in any environment for a full week (40 hours) between battery recharges. Audible and visual alarms automatically warn of the presence of combustible gas, oxygen deficiency or low battery voltage.

The combustible gas sensor employs an advanced ceramatized gas sensing element insuring long life. The proven BMI galvanic oxygen sensor is self-powered and never requires rebuilding or recharging. The 900 is fully temperature compensated from 5°F to 110°F and meets U.S. Bureau of Mines intrinsic safety requirements.

The 900 may also be used in spot checking for both oxygen and combustible gas at the press of a button.

Each unit comes with a remote sampling kit. The unit is housed in a rugged leather carrying case and may be worn on the belt or on the shoulder. The 900 is completely solid state with no moving parts to wear out. A loud, penetrating remote alarm is available to provide additional warning of alarm conditions to outside or "topside" personnel.

The 900 is particularly useful in mines, tunnels, silos, tanks, ship holds, railroad tank cars, manholes, sewers and other locations in the chemical, petroleum, mining, utilities and shipping industries where combustible gases and oxygen deficiencies may be found.

DIMENSION - 4 x 8 x 3

WEIGHT - 3 lbs.

SCALE - 0 - 100% LEL Combustible gas
0 - 40% Oxygen
0 - 5% Methane

RESPONSE TIME - Oxygen - 10 sec.
Combustible gas - 5 sec.

RECHARGE TIME - Less than 16 hours

BioMarine Industries
303 West Lancaster Avenue
Devon, Pennsylvania, 19333
215:687-2800 • Cable:BIOMAR

MODEL 900 COMBUSTIBLE GAS/OXYGEN MONITOR

OPERATING AND MAINTENANCE INSTRUCTIONS

WARNING: These instructions must be read and understood by all individuals who will have the responsibility of operating and servicing the Combustible Gas/Oxygen Monitor. The actions taken as a result of the measured oxygen and combustible gas levels must be in strict accordance with Company and Government regulations. The instrument should not be used to measure combustible gas in atmospheres either oxygen deficient or containing more than 25% oxygen by volume.

GENERAL

The BioMarine Combustible Gas/Oxygen Monitor provides a simple method of determining oxygen concentrations and combustible gas levels in any environment. The instrument may be used for both spot checks and continuous monitoring with alarms. When used as a monitor, oxygen level and battery voltage are monitored continuously and Combustible Gas level is checked automatically every three minutes. This "sampled data" approach allows forty hours continuous operation before battery recharging. Easily portable and simple to operate, the Monitor is automatically temperature compensated over its full operating range of 5°F to 110°F. The Monitor requires infrequent calibration and performs accurately in high humidity environments. While methane is the calibration standard for the combustible gas monitor, other combustible gases will be detected. If desired, combustible gases other than methane may be used for calibration.

CAUTIONS

1. The battery must be tested before the monitor is used.
2. In combustible gas concentrations above 100% LEL, the instrument will give incorrect readings. If it is suspected that concentrations higher

APPENDIX 4

Emergency Notifications

Notification of Coast Guard and Navy Rescue Organizations

Prior to commencement of the at-sea portion of the project, Woods Hole Institute shall notify the Coast Guard in accordance with Coast Guard Notice 3130, by completing and submitting USCG Form 4790 (8-71), "Summary of Planned Submersible Operations." This form will be sent to Commander, 3rd Coast Guard District, New York. The Commander of the 3rd Coast Guard District will notify appropriate Navy authorities of the impending operation, and will issue a warning to mariners giving location and time of operations in order to minimize interferences during the operations.

If the submersible should be unable to surface, the support ship shall radio a MAYDAY message to the Coast Guard on 2182 kHz, and other emergency circuits as may be available. The Coast Guard Rescue Coordination Center (N.Y.C.) may be reached using a telephone call via the marine operator at 212-264-4800.

Upon receipt of the MAYDAY message, the Coast Guard will proceed in accordance with Commandant Instruction 3130.7D of 5 December 1975. If Navy assistance is appropriate, the Coast Guard will so request by calling the Navy Department Duty Captain at 202-695-0231. The Navy Duty Captain will take action in accordance with OPNAV Instruction 3130.4A of 29 October 1973. Applicable portions of Coast Guard Instruction 3130.7D and OPNAV Instruction 3130.4A are presented hereinafter:

G-M-2/82

DEPARTMENT OF TRANSPORTATION

UNITED STATES COAST GUARD

MAILING ADDRESS:
U.S COAST GUARD (G-M-2/USP/83)
400 SEVENTH STREET SW.
WASHINGTON. D.C. 20590
PHONE (202) 426-2307

PLANNING & SPECIAL PROJECTS STAFF COMDTINST 3130.7D

5 DEC 1975

DEC 17 1975

COMMANDANT INSTRUCTION 3130.7D

Subj: Operations Involving Civilian Submersibles

1. Purpose. This Instruction provides procedures to be followed by the Coast Guard with respect to operations involving civilian submersibles.

2. Cancellation. Commandant Instruction 3130.7C CH-1 is cancelled.

3. Discussion.

a. The Coast Guard's search and rescue responsibilities extend to vessels operating under, as well as on, the surface of the sea. These responsibilities therefore include the small number of civilian submersibles which operate in or near U.S. waters on scientific, industrial or other missions. The safety record of these submersibles has been good, but the few accidents have demonstrated both the difficulty of rescue and the potential for public interest. The Coast Guard has no special undersea search and rescue equipment to assist a submersible unable to surface and must discharge its responsibility by requesting suitable equipment be brought to the scene. Equipment is available which could effect a rescue in most situations, but frequently information on the location and status of the equipment is not available. The primary source of expertise and equipment is the U.S. Navy, and procedures have been established to permit utilization of Navy resources in the event of a civilian submersible SAR incident. A single point of contact has been established, as the Navy can provide not only fleet resources but specialized experimental equipment located at laboratories, and also civilian specialists retained on contract for undersea salvage. The point of contact is the Navy Department Duty Captain at the Pentagon, as described in OPNAVINST 3130.4, enclosure (1). When the Navy has responded and assumed the role of SAR Mission Coordinator, the Coast Guard role becomes one of support. Until that time the Coast Guard must respond with its own resources and whatever local civilian or government help is available.

b. Submersible operations present another problem. This is one of interference with Navy operations. To enable the Navy to reduce this possibility, to reduce the chance of classifying a civilian submersible as an unknown submerged vessel necessitating investigation, and to aid in prompt SAR assistance the Commandant has established a voluntary reporting system through which pertinent information can be relayed to concerned parties. The Commandant (G-M-2/USP/83) monitors submersible activity and advises known submersible operators of the reporting system and the procedure for requesting assistance if needed.

c. There is no mutual assistance plan, formal or informal, in effect among the submersible operators. Most operators, however, could be expected to be willing to assist in the rescue of a distressed submersible.

4. <u>Action</u>

a. Commandant (G-M-2/USP/83)

(1) Inform all known submersible operators and owners in the United States of the voluntary reporting system. Enclosure (2) is a copy of the notice used for this purpose.

(2) Maintain liaison with the Navy and other organizations to provide coordinated planning for submersible emergencies.

(3) Distribute periodic reports on the status of U.S. submersibles to all District Commanders. Coordinate the distribution of appropriate informational material to District Commanders (RCC's). The following publications are currently distributed automatically:

<u>Deep Submergence Systems Summary and Characteristics Manual:</u> Published and revised annually by Commander Submarine Development Group One as COMSUBDEVGRU ONE INSTRUCTION 5450.1 and contains characteristics of U.S. military and civilian submersibles, unmanned undersea systems, and habitats.

<u>An Inventory of Navy Laboratory R&D Equipment Available for Emergency Undersea Operations:</u> Published by and revised annually by Naval Undersea Center, San Diego as NUC AP-2.

b. District Commanders

(1) On receipt of information on planned submersible operations disseminate this information by message as described in enclosure (3). Issue a Notice to Mariners as appropriate giving the location and time(s) of operations to minimize interference during the operations.

(2) In the event that a specific request for assistance to a civilian submersible is received:

(a) Obtain Navy assistance, if appropriate, by calling the Navy Department Duty Captain in the Pentagon at the following phone number, notifying him of the situation:

COMMERCIAL (202) 695-0231

AUTOVON 22-50231

If appropriate request implementation of SUBMISS/SUBSUNK for civilian submersibles in accordance with OPNAV INSTRUCTION 3130.4, and the USN ADDENDUM to NWP 37(B). Send a follow-up message in the format of enclosure (4) to confirm the request.

(b) Respond with appropriate Coast Guard resources, such as On-Scene Commander rescue platform (buoy tender), traffic control, communications, and logistics.

(c) Ascertain if there are any other civilian submersibles available; request that they assist the distressed sub.

(d) Coordinate the response as SAR Mission Coordinator (SMC) until the Navy assumes this responsibility. Continue to provide any assistance requested after the Navy assumes SMC. Ensure that the AREA COMMANDER and the COMMANDANT are kept informed of the progress of the rescue both before and after the Navy assumes SMC.

(e) Until the Navy assumes SMC (and in case the Navy is unable to assume SMC) obtain advice from Headquarters Flag Plot and make use of best available military and civilian resources. A brief guide to RCC controllers in handling submersible SAR incidents is printed by and available from the National Search and Rescue School, Governors Island, New York.

(f) Prepare a SAR Case Study in addition to the normal assistance report.

5. <u>Availability of Forms</u>.

a. Commandant (G-M-2/USP/83) shall distribute the SUMMARY OF PLANNED SUBMERSIBLE OPERATIONS (CG-4790) to all known owners, operators, and manufacturers of civilian submersibles in the United States and to all RCC's.

b. Additional copies of Form (CG-4790) may be obtained from Commandant (G-M-2/USP/83).

R. H. SCARBOROUGH
Chief of Staff

Encl:
(1) OPNAVINST 3130.4B
(2) Notice to all owners, operators, and manfacturers of civilian submersibles
(3) Message format for planned submersible operations
(4) Message format for requesting Navy to implement EVENT SUBMISS/SUBSUNK

List CG-10
Dist: (SDL No. 101)
A: acde (3);gfhmv (2); ijnou (1)
B: n (45); c (20); f (15); g (11); e (10); r (7); h (6); bm (3); dpq (1); j(2)
C: a (5); bdn (3); go (2); q (1)
D: a (2); dsu (1)
E: do (1)
None

CNO OP-23 (5)
CNO OP-943 (5)
SUPSALV (5)
CINCLANTFLT (5)
CINCPACFLT (5)
COMSECONDFLT (5)
COMTHIRDFLT (5)
COMSUBLANT (5)
COMSUBPAC (5)
NAVOCEANO (5)
COMSUBFLOT 1 (2)
COMSUBFLOT 2 (2)
COMSUBFLOT 5 (2)
COMSUBFLOT 6 (2)
COMSUBFLOT 7 (2)
COMSUBRON 6 (2)
COMSUBRON 12 (2)
COMSUBDEVGRU 1 (2)

DEPARTMENT OF THE NAVY
OFFICE OF THE CHIEF OF NAVAL OPERATIONS
WASHINGTON, D.C. 20350

IN REPLY REFER TO
OPNAVINST 3130.4A
Op-232
29 OCT 1973

OPNAV INSTRUCTION 3130.4A

Subj: OPNAV Manned Non-Combatant Submersible SUBMISS/SUBSUNK Bill (R

Encl: (1) Washington Area Notification List (A
(2) Information regarding action to be taken in the Washington area
(3) General information regarding manned non-combatant submersibles (R

1. Purpose. The purpose of this bill is to ensure that the Navy Department is alerted to provide assistance whenever a SUBMISS/SUBSUNK is executed for a manned non-combatant submersible.

2. Cancellation. OPNAV Instruction 3130.4 dated 18 July 1969 is hereby superseded. (A

3. Scope. This bill serves to advise the Navy Department duty captain, Navy Command and Support Center (NCSC) of the following: (R

a. Action to be taken by him to alert the Navy Department or initiate appropriate U. S. Navy action if required.

b. Action to be taken by other activities in the Washington area.

4. Discussion (A

a. In the event of loss of a manned non-combatant submersible operated by the U. S. Navy or operating under a Navy lease, "Event SUBMISS/SUBSUNK" will be placed in effect by the Submarine Operating Authority in whose area the submersible is operating.

b. In the event of the loss of a civilian submersible not operated by or under lease to the U. S. Navy, the U. S. Coast Guard may request Navy assistance in accordance with the National Search and Rescue Plan, 1969. Under federal law, the Coast Guard is responsible for developing, establishing, maintaining and operating, with due regard to the requirements of national defense, rescue facilities for the promotion of safety on, under and over the high seas and waters subject to the jurisdiction of the United States. The Coast Guard has issued an instruction on civilian submersible operations, Commandant Instruction 3130.7 series. The Navy is assigned no direct responsibility in the National SAR Plan for the rescue of personnel or salvage of civilian owned and operated submersibles. However, provision is made for the use of Navy facilities to meet civil needs on a basis of non-interference with higher priority military missions. If Navy assistance is requested by the Coast Guard, "Event SUBMISS/SUBSUNK" may be placed in effect by the duty captain after consultation with the appropriate fleet commander and the Deputy Chief of Naval Operations (Submarine Warfare). If "Event SUBMISS/SUBSUNK" is declared, the Navy will respond to the fullest extent possible within its existing capabilities. When Navy assistance is provided, the cognizant Coast Guard area or district commander will designate the senior U. S. Navy officer on scene as the on-scene commander. That officer shall be qualified for succession to command at sea, and if practicable, will be a submarine officer serving in a submarine billet.

c. The provisions of this instruction will cease to apply should the operation become simply one of a salvage nature. Appropriate salvage instructions will then apply. This could occur should:

(1) The personnel in the disabled vehicle escape or be rescued and the submersible or parts thereof remain on the bottom.

(2) The personnel entrapped have exhausted their life support and rescue is no longer possible.

R) 5. Action. When a manned non-combatant submersible emergency arises, the Navy Department duty captain shall:

a. Call those listed in enclosure (1) and inform them of the situation.

b. Coordinate as necessary any actions or assistance that may be required from assets not under the command of the search and rescue mission coordinator.

c. Declare SUBMISS/SUBSUNK, if appropriate, upon receipt of a request for assistance from the Coast Guard and after consultation with the proper fleet commander and the DCNO (Submarine Warfare).

E. P. WILKINSON
Deputy Chief of Naval Operations
(Submarine Warfare)

Distribution:

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A5	Bureaus	(R
B1	Secretary of Defense	(A
B3	Colleges	(A
B5	U.S. Coast Guard (Commandant, only)	(A
21A	Fleet Commanders in Chief	
22	Fleet Commanders	(A
23	Force Commanders	(A
24	Type Commanders	(R
26VV	Submarine Force Representatives	(A
26WW	Deep Submergence Rescue Vehicle and Deep Submergence Vehicle	(A
26YY	Fleet Ocean Surveillance Information Facility and Center	(A
27	Administrative Commands and Units	(R
28K	Submarine Groups and Squadrons	(R
29S	Submarines	(A
31	Amphibious Warfare Ships	(A
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(Continued on Page 4)

OPNAVINST 3130.4A
2 9 OCT 1973

Distribution (Continued)

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A)	FB13	Submarine Base PAC
A)	FB15	Submarine Support Facility
A)	FB38	Oceanographic Systems Pacific
A)	FC1	Fleet Operations Control Center NAVEUR
	FD1	Oceanographer of the Navy
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A) Ops 00, 09, 09B, 09C, 09D, 09F, 090, 90, 91, 96, 097, 094, 941, 943, 945, 947, 948, 095, 951, 952, 098, 981, 982, 983, 985, 987, 008, 009, 01, 02, 21, 22, 23, 29, 03, 32, 04, 40, 41, 43, 45, 05, 50, 06, 60, 61 and 62

Stocked:

CO, NAVPUBFORMCEN
5801 Tabor Avenue
Philadelphia, Pa 19120

WASHINGTON AREA NOTIFICATION LIST

CNO (Op-00)
VCNO (Op-09)
DCNO (Submarine Warfare) (Op-02)
DepSubProgCoord (Op-23)
SECNAV
UNSECNAV
President's Naval Aide
*NMCC
DIRCMDSUPROG (Op-094)
DIRFLTOPSREANAVCOMSUPDIV (Op-943)
DCNO (Air Warfare) (Op-05)
DCNO (Surface Warfare) (Op-03)
Head, Submarine Branch (Op-951E)
Assistant for Surveillance Operations (Op-951F3)
CHINFO
DCNO (Logistics) (Op-04)
CNM Command Center
**NAVSHIPS Duty Officer
***BUPERS Duty Officer
NAVDIST Washington Duty Officer
OIC NAVXDIVINGU
BUMED Duty Officer
NAVMAT 034
Naval Oceanographic Office Duty Officer
****DIR ATOMIC ENERGY DIV (Op-985)

* To further alert ASTSECDEF (PA) & ASTSECDEF (Atomic Energy) if nuclear vessel involved

** To further notify Codes 04, 425, 395 & OOC. Code 08 if nuclear vessel involved

*** To further alert Director, Personal Services Division and Casualty Branch

**** If nuclear vessel involved

INFORMATION REGARDING ACTION TO BE TAKEN IN THE WASHINGTON AREA

1. Upon receipt of information that a manned non-combatant submersible SUBMISS/SUBSUNK event has been executed, the duty captain will notify the persons and activities listed on the notification list (enclosure (1)) using the most expeditious means available. (R

2. Upon receipt of a request for Naval assistance from a cognizant Coast Guard area or district commander in the event of the loss of a civilian submersible, the duty captain initiates event SUBMISS/SUBSUNK, designating the appropriate fleet commander in chief to take the necessary action and authorizing direct liaison with the cognizant Coast Guard commander. He will notify the persons and activities listed in the notification list that SUBMISS/SUBSUNK has been placed in effect. (R

3. The Director, Fleet Operations, Readiness, Navy Command Support Division (Op-943) with the assistance of the Director, Deep Submergence Systems Division (Op-23) and the Supervisor of Salvage, will coordinate CNO's action. (R

4. Commander Submarine Development Group One will be alerted to provide staff assistance to the on-scene commander, if requested, and to make ready his search, recovery and rescue assets.

5. The Naval Ship Systems Command Headquarters duty officer will alert the Submarine Division (Code 425), the Deep Submergence Project Office (PMS-395) and the Supervisor of Salvage (Code 00C) so that any requirements for material can be furnished expeditiously. The NAVSHIPSYSCOMHQ duty officer shall also alert the Nuclear Power Directorate (Code 08) if a nuclear submarine is involved. (R

6. The Experimental Diving Unit will be ready to furnish a qualified diving officer, diving medical officer, additional divers, and diving and rescue gear depending on the nature of the casualty.

7. The Chief of Naval Personnel is responsible for the notification of next of kin in the event of the presence of naval personnel aboard the submersible. Therefore, the (R

BUPERS duty officer will be notified and directed to alert the Director, Personal Services Division and the Casualty Branch for effecting notification of next of kin. In the case of a Navy operated or leased submersible the commanding officer, commander or director of the Navy organization operating the submersible will be tasked to provide the Bureau of Naval Personnel with a copy of the sailing list and next of kin information by the most expeditious means. The BUPERS duty officer will also alert the Office of Liaison and Public Affairs for coordinating release of names of casualties for publication.

8.e The Op-05 duty officer is to be alerted on the presumption that there will be personnel or items of materiale to be flown to the vicinity of the casualty.e

A)e 9. The Chief of Information will be alerted to draft ore assist in drafting a press release. This release will note be issued until cleared by the duty captain.e

R)e 10. Copies of the manned non-combatant deep submersiblee SUBMISS/SUBSUNK plans are kept in a binder labeled "Submarine Disaster Notebook" held by the duty captain.e

Enclosure (2)

GENERAL INFORMATION REGARDING
MANNED NON-COMBATANT SUBMERSIBLES

1. Deep submersibles are generally designed to perform specific ocean engineering tasks. As a result, the size, hull form and equipment arrangements are usually quite different.

2. Deep submersibles have the following common characteristics: (R

a. Life support systems capacity varies and is generally less than 24 hours. Some exceptions are the Submarine NR-1 and USS DOLPHIN.

b. The hatches on the deep submersibles are normally not compatible with the Deep Submergence Rescue Vehicles (DSRVs) and Submarine Rescue Chambers (SRCs) used for submarine rescue.

c. Deep submersibles are usually not designed for escape using buoyant ascent. Again the deep diving submarines USS DOLPHIN and Submarine NR-1 are exceptions.

d. At the present time the only feasible method of saving the lives of an untethered manned non-combatant deep submersible crew would be to salvage the vessel.

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

MAILING ADDRESS
U S COAST GUARD (G-M-2/USP/83)
400 SEVENTH STREET SW
WASHINGTON, D.C 20590
PHONE (202) 426-2307

3130

NOTICE

TO ALL OWNERS, OPERATORS, AND MANUFACTURERS OF CIVILIAN SUBMERSIBLES

While the development of submersibles is a step forward in our nation's progress, it also creates some unique problems. Among these are the possibility of interference with Navy operations, being detected and classified as an unknown submerged vessel requiring investigation, and becoming disabled and trapped on the ocean floor. In order to reduce the possibility that these situations will occur and to provide rapid determination of the location of a disabled submersible and of potential rescue submersibles, the Coast Guard has established a voluntary reporting system through which pertinent information can be relayed to appropriate parties.

The voluntary reporting system requests that Enclosure (1), "Summary of Planned Submersible Operations," be filled out and transmitted, by mail or phone, to the nearest Coast Guard District Commander prior to each planned operation. Dissemination of this information will be as follows: forwarded to cognizant Navy authorities in order to avoid conflict with Navy operations; issued (location and time only) in appropriate Notices to Mariners unless otherwise requested; and retained in the Rescue Coordination Center (RCC) until a reasonable time after the estimated completion of operations. Additional forms are available from the District Commander.

If a situation arises where your submersible requires assistance, contact the nearest Coast Guard District Commander through his RCC. The District Commander will be able to determine from the voluntary reporting system if there are any other submersibles in the vicinity who could be requested to provide assistance. Procedures have also been developed for requesting assistance from the Navy. The Coast Guard will coordinate the rescue operation and provide support with its extensive communications network and its fleet of ships and aircraft.

For your convenience, a list of Coast Guard District Commanders and the phone numbers of their Rescue Coordination Centers is enclosed.

Encl: (1) Summary of Planned Submersible Operations form CG-4790
(2) List of Coast Guard District Commanders

Form Approved
OMB No. 04-R3050

DEPARTMENT OF TRANSPORTATION U. S. COAST GUARD CG-4790 (8-71)	SUMMARY OF PLANNED SUBMERSIBLE OPERATIONS

NOTE: The following information is voluntarily submitted to the Coast Guard for dissemination to minimize operational interference and to facilitate emergency action if needed.

NAME OF SUBMERSIBLE	CALL SIGN
NAME OF COMPANY (OWNER)	FREQUENCIES GUARDED
NAME OF SUPPORT SHIP	RADIO WATCH SCHEDULE
PORT OF DEPARTURE	TIME AND DATE OF DEPARTURE

DATE	ESTIMATED TIME OF DIVE	ESTIMATED TIME OF SURFACE	LOCATION OF OPERATING AREA	WATER DEPTH

NEXT PORT OF CALL	TIME AND DATE OF ARRIVAL

During the next inport period, it is anticipated that the submersible will be maintained in a state of readiness such that it would require about ______ hours to make it ready to dive.

COMMENTS

DATE	SIGNATURE AND TITLE

ENCLOSURE (1)

FOLD AND SEAL

DEPARTMENT OF TRANSPORTATION
U. S. COAST GUARD

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Commander
1st Coast Guard District
Boston SAR Coordinator
Rescue Coordination Center
150 Causeway St.
Boston, MA 02114
Phone No. (617) 223-3645

Commander
2nd Coast Guard District
St. Louis SAR Coordinator
Rescue Coordination Center
Federal Building
1520 Market St.
St. Louis, MO 63103
Phone (314) 425-4614

Commander
3rd Coast Guard District
New York SAR Coordinator
Rescue Coordination Center
Governors Island
New York, NY 10004
Phone No. (212) 264-4800

Commander
5th Coast Guard District
Portsmouth SAR Coordinator
Rescue Coordination Center
Federal Building
431 Crawford St.
Portsmouth, VA 23705
Phone No. (804) 393-9231

Commander
7th Coast Guard District
Miami SAR Coordinator
Rescue Coordination Center
Federal Bldg., Room 1018
51 S.W. 1st Ave.
Miami, FL 33130
Phone No. (305) 350-5611

Commander
8th Coast Guard District
New Orleans SAR Coordinator
Rescue Coordination Center
Customhouse
New Orleans, LA 70130
Phone No. (504) 589-6225

Commander
9th Coast Guard District
Cleveland SAR Coordinator
Rescue Coordination Center
1240 East 9th St.
Cleveland, OH 44199
Phone No. (216) 522-3984

Commander
11th Coast Guard District
Long Beach SAR Coordinator
Rescue Coordination Center
Heartwell Bldg.
19 Pine Ave.
Long Beach, CA 90802
Phone No. (213) 590-2225

Commander
12th Coast Guard District
San Francisco SAR Coordinator
Rescue Coordination Center
630 Sansome St.
San Francisco, CA 94126
Phone No. (415) 556-5500

Commander
13th Coast Guard District
Seattle SAR Coordinator
Rescue Coordination Center
915 2nd Ave.
Seattle, WA 98174
Phone No. (206) 442-5886

Commander
14th Coast Guard District
Honolulu SAR Coordinator
Rescue Coordination Center
P.O. Box 48
FPO San Francisco, 96610
Phone No. (415) 556-0220
Ask for 808-546-7109

Commander
17th Coast Guard District
Juneau SAR Coordinator
Rescue Coordination Center
FPO Seattle, 98771
Phone No. (206) 442-0150
Ask for 907-586-7340

From: CCGD____ (COAST GUARD DISTRICT)

Pacific-East of 145°W

Action: COMSUBGRU FIVE
COMTHIRDFLT

Info: CINCPACFLT
COMSUBPAC
COMSUBDEVGRU ONE
CNO
COMDT COGARDC
COMPACAREA COGARDC

Pacific-Between 145°W and 160°E

Action: COMSUBPAC
COMTHIRDFLT

Info: CINCPACFLT
COMSUBDEVGRU ONE
CNO
COMDT COGARD
COMPACAREA COGARD

Pacific-West of 160°E

Action: COMSUBGRU SEVEN
COMTHIRDFLT

Info: CINCPACFLT
COMSUBPAC
COMSUBDEVGRU ONE
CNO
COMDT COGARD
COMPACAREA COGARD

Atlantic, Gulf of Mexico, and Caribbean Sea

Action: COMSUBLANT
COMSECONDFLT

Info: CINCLANTFLT
COMSUBDEVGRU ONE
CNO
COMDT COGARD
COMLANTAREA COGARD

BT

REPORT OF PLANNED SUBMERSIBLE OPERATIONS

A.C COMDT COGARD INST 3130.7DC

1.C SUBMERSIBLE________ WILL CONDUCT DIVING OPERATIONS________ (LOCATION)C ________ DURING THE PERIOD________ TIME (DAYS)C

2.C DESCRIBE (IF POSSIBLE) MISSION (e.g. CABLE BURIAL, OCEANOGRAPHY, PIPELINEC INSPECTION) AND DEPTH OF WATER.C

3. MOTHER VESSEL WITH DESCRIPTION, CALL SIGN, AND FREQUENCIES GUARDED.C

4.C LIFE SUPPORT ENDURANCE, NUMBER OF CREW (IF POSSIBLE).C

5.C RESCUE CAPABILITY ON SCENE, SPECIAL RESCUE FITTINGS.C

BT

(NOTE THAT EXACT TIMES AND LOCATIONS OF DIVES ARE USUALLY NOT AVAILABLE AND NEED NOT BE REQUIRED)

FM: CCGD______ (COAST GUARD DISTRICT)

ACTION: CNO (CHIEF OF NAVAL OPERATIONS)

INFO: COM______ AREA (COMMANDANT AND AREA OFFICES, U.S. COAST GUARD)

BT

UNCLAS

DISTRESS CIVILIAN SUBMERSIBLE________

A. OPNAVINST 3130.4A (SUBJ: CHIEF OF NAVAL OPERATIONS MANNED NON-COMBATANT SUBMERSIBLE SUBMISS/SUBSUNK BILL; PROMULGATION OF)

B. USN ADDENDUM TO NWP 37 (B)

1. REQUEST IMPLEMENT EVENT SUBMISS/SUBSUNK FOR SUBJECT VESSEL.

2. SITUATION (DESCRIBE SITUATION INCLUDING AS MUCH AS POSSIBLE OF THE FOLLOWING INFORMATION).

   (a) LOCATION

   (b) MOTHER VESSEL, CALL SIGN, FREQUENCIES

   (c) DEPTH OF WATER

   (d) WEATHER ON SCENE

   (e) LIFE SUPPORT TYPE AND DURATION

   (f) RESCUE CAPABILITY ON SCENE

   (g) RESCUE FITTINGS

3. ACTION TAKEN (INCLUDE DESIGNATION OF ON SCENE COMMANDER AND SAR MISSION COORDINATOR).

BT

DISTRIBUTION LIST

Commander, 3rd Coast Guard District
New York SAR Coordinator
Rescue Coordination Center
Governors Island, NY 10004

Commander, U.S. Coast Guard
(GM-2/USP/83)
Washington, D. C. 20054

Commander, Submarine Force
U.S. Atlantic Fleet
Norfolk, VA 23521
ATTN: Code N-311B

U.S. Navy Supervisor of Salvage
NAVSHIPS OOC
2531 Jefferson Davis Highway
Arlington, VA 20362

Commander, Submarine Development
Group One
Building 139, Syslvester Road
San Diego, CA 92106

Commander, 5th Coast Guard District
Portsmouth SAR Coordinator
Rescue Coordination Center *
Federal Building
431 Crawford Street
Portsmouth, VA 23705

U.S. Coast Guard 7th District
ATTN: OSR
51 SW 1st Avenue
Miami, FL 33130

NOAA Safety Engineer
c/o Edwin McCann
Code AD-1
6010 Executive Blvd.
Rockville, MD 20852

Department of the Navy
Office of the Chief of Naval Operations
ATTN: Capt. E. E. Henifin (OP-23)
Washington, D.C. 20350

Commander, Submarine Group 2
Box 52, Naval Submarine Base
Groton, CT 06340

APPENDIX 5

Figures

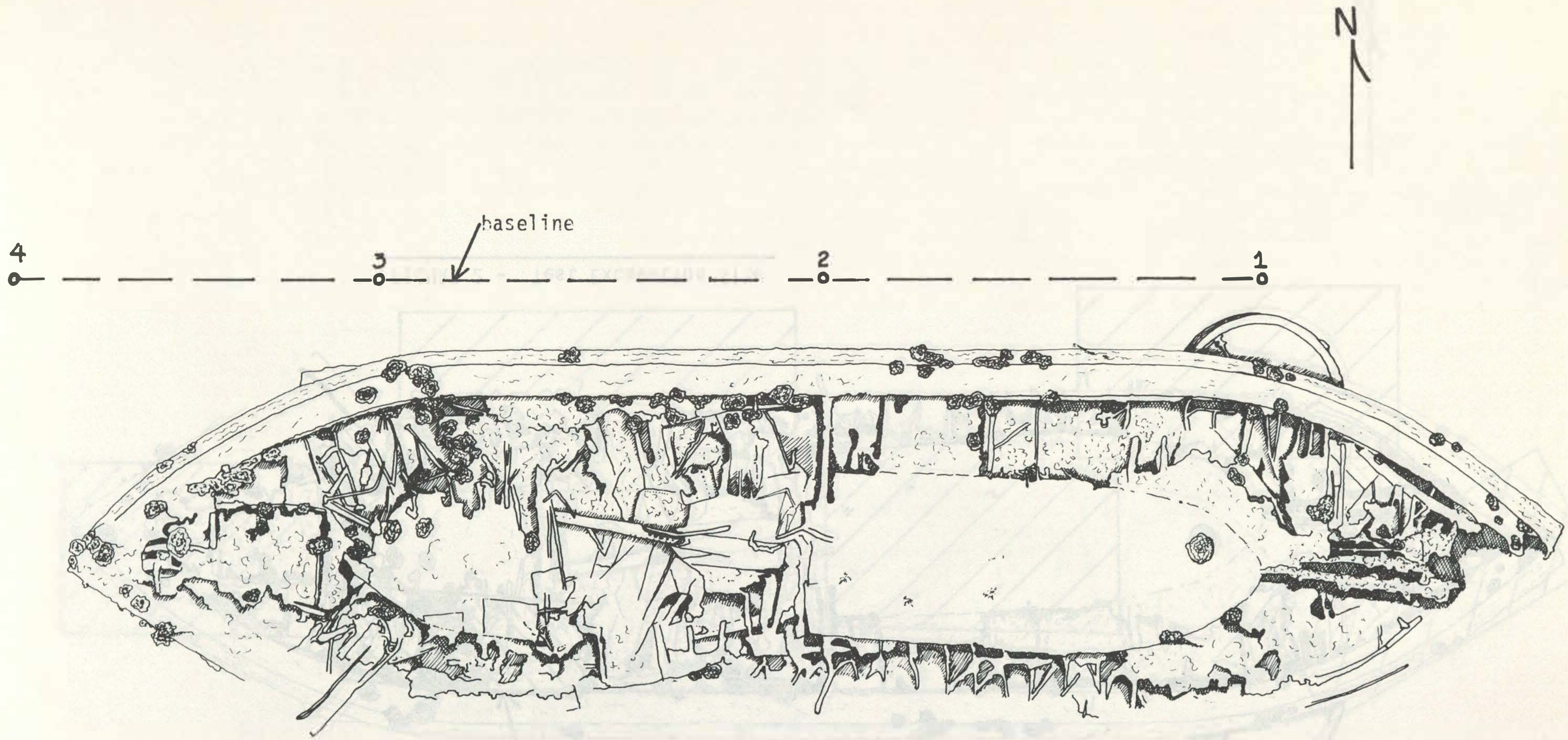


FIGURE 1 - Location of Permanent Control Datum Points

o-Datum Locations

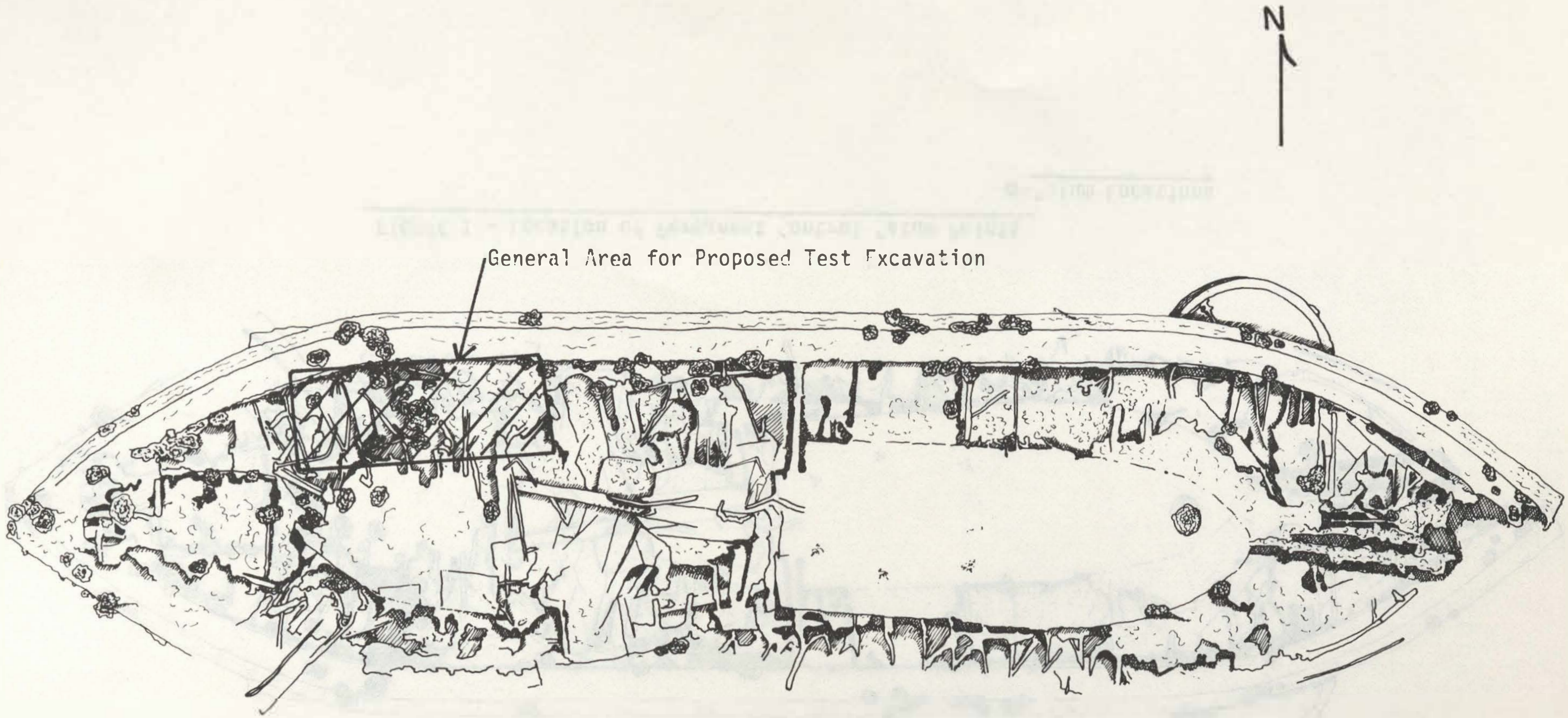


FIGURE 2 - Test Excavation Site

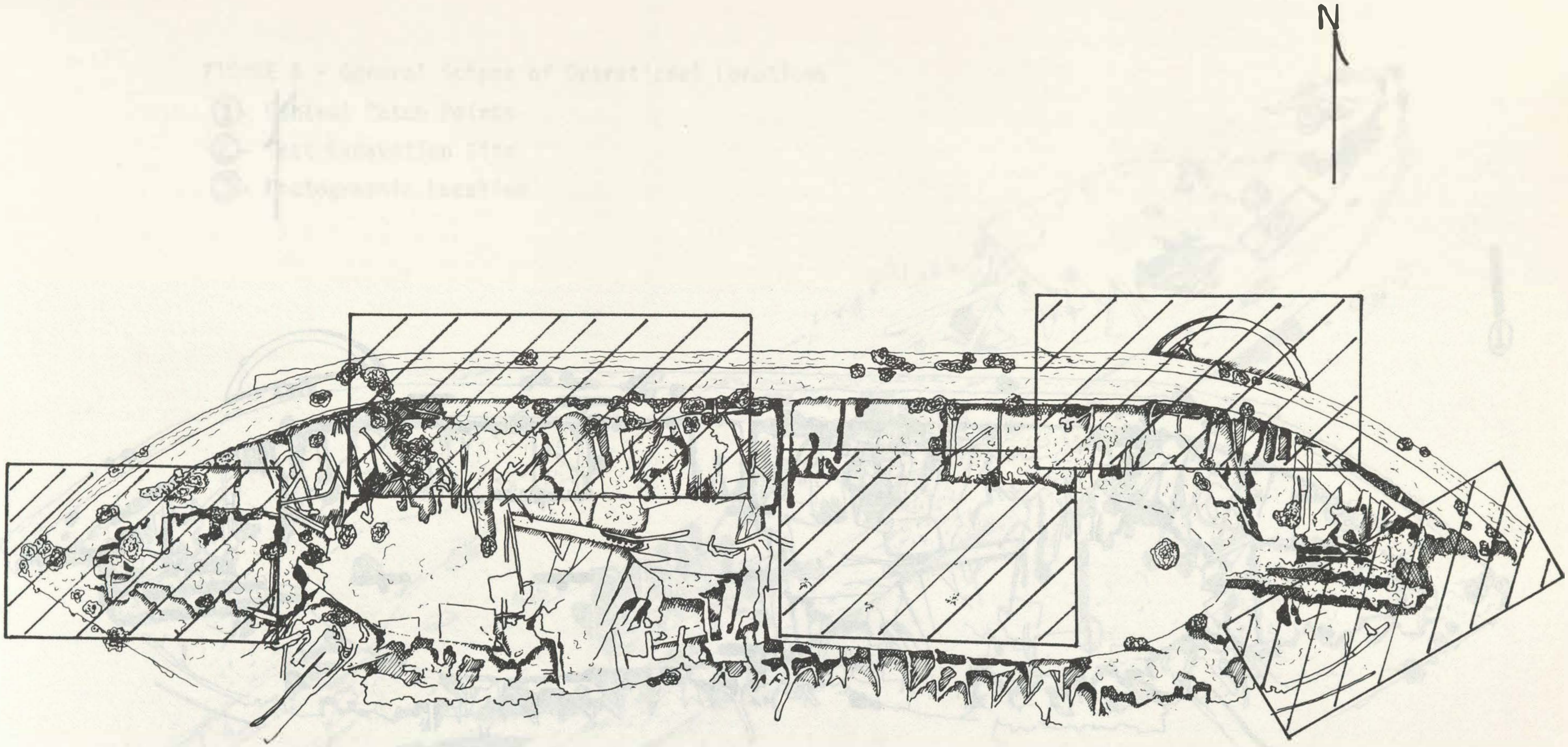


FIGURE 3 - Photographic Locations

[hatched box] - General Vicinity

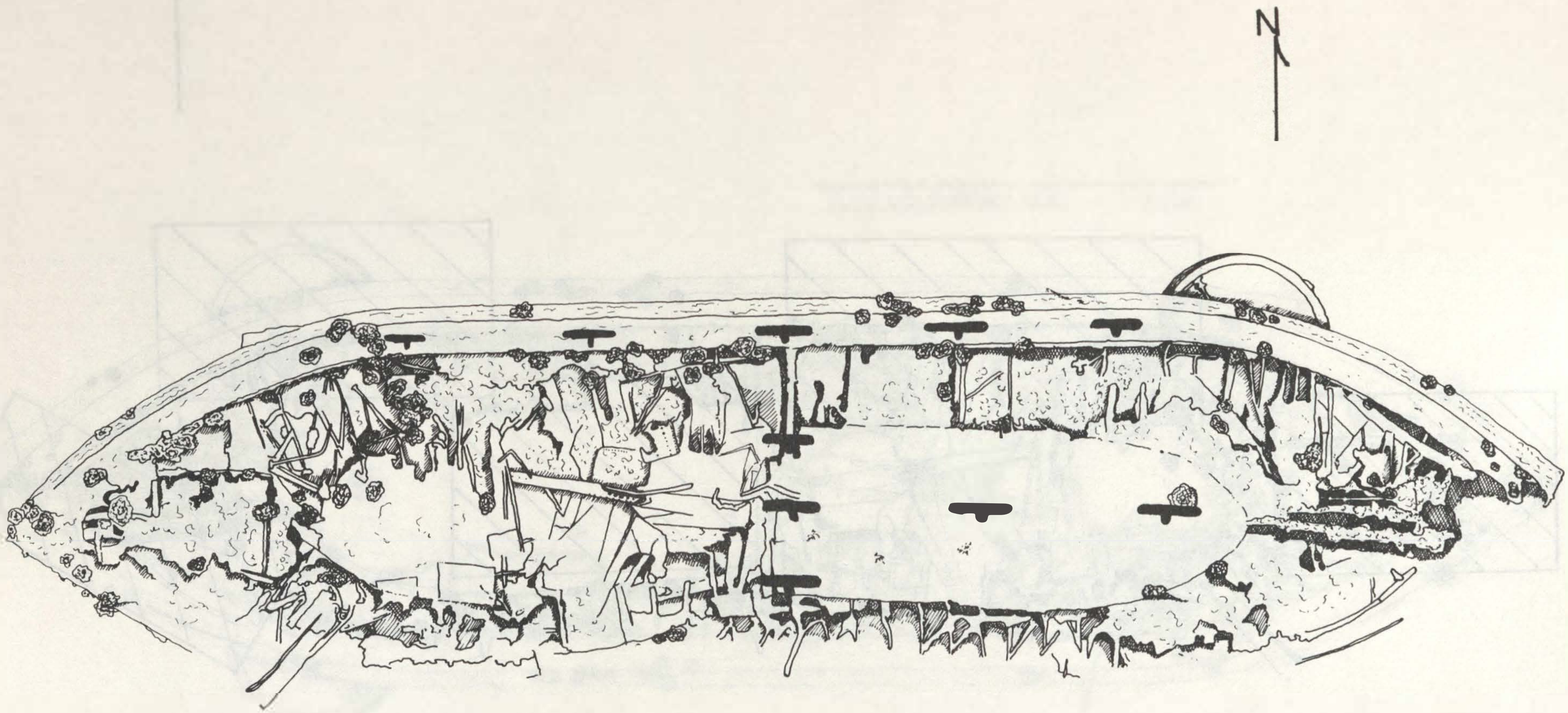


FIGURE 4 - Attitude Analysis

- General Location of Inclinometer Readings

FIGURE 5 - General Scheme of Operational Locations

(1)- Control Datum Points

(2)- Test Excavation Site

(3)- Photographic Location

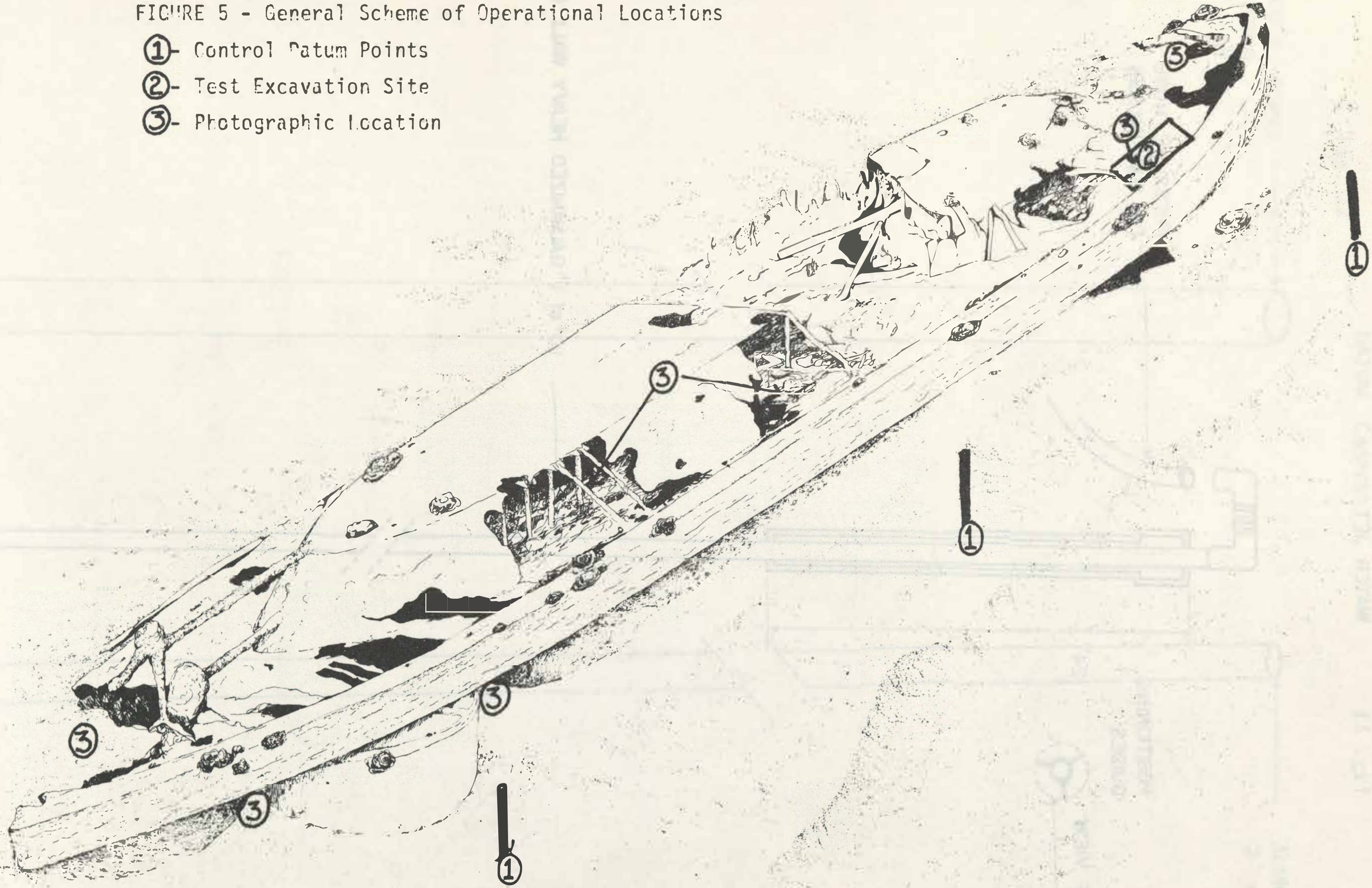


Fig. 11 WATER JET

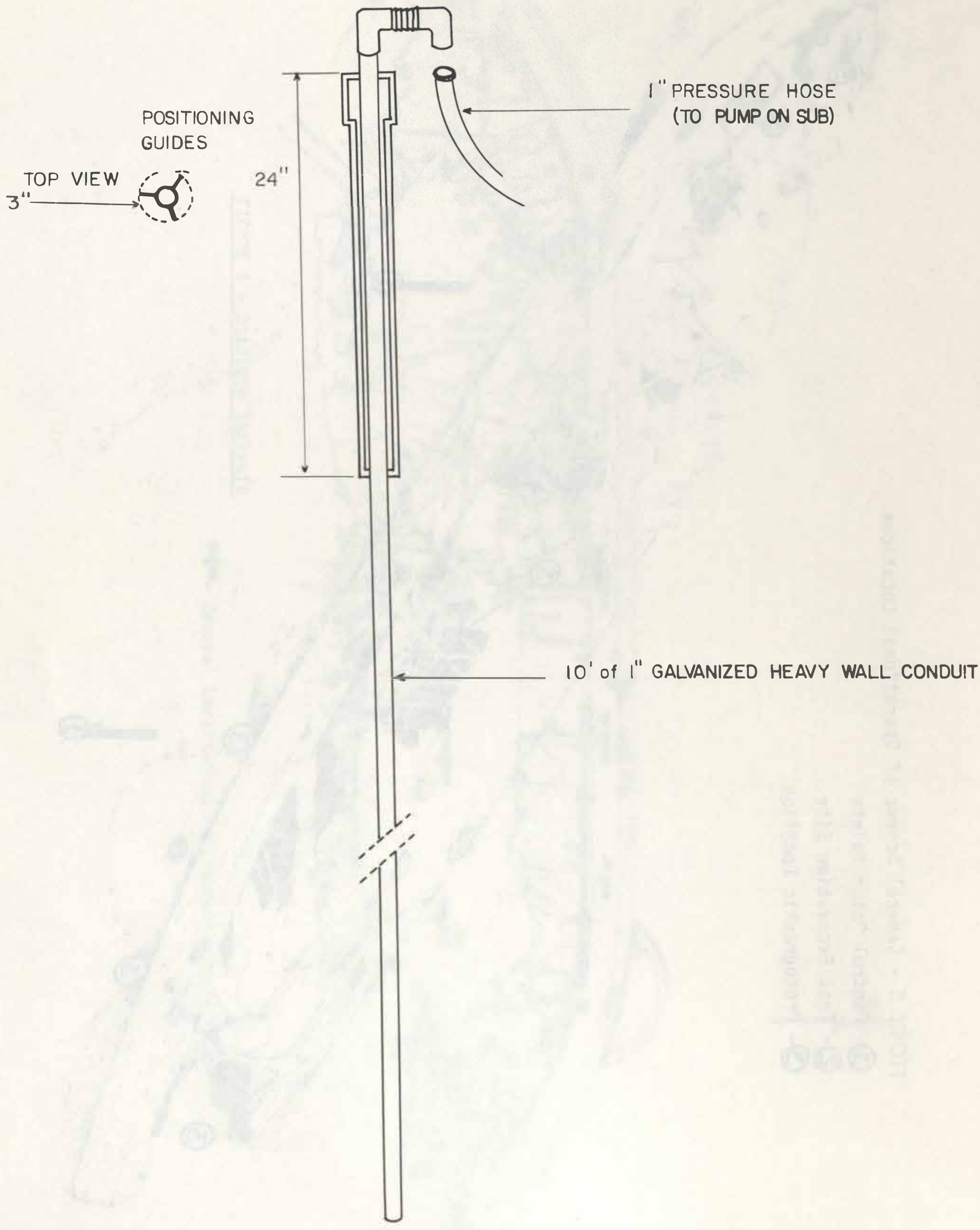


Fig. 12

DATUM CASINGS

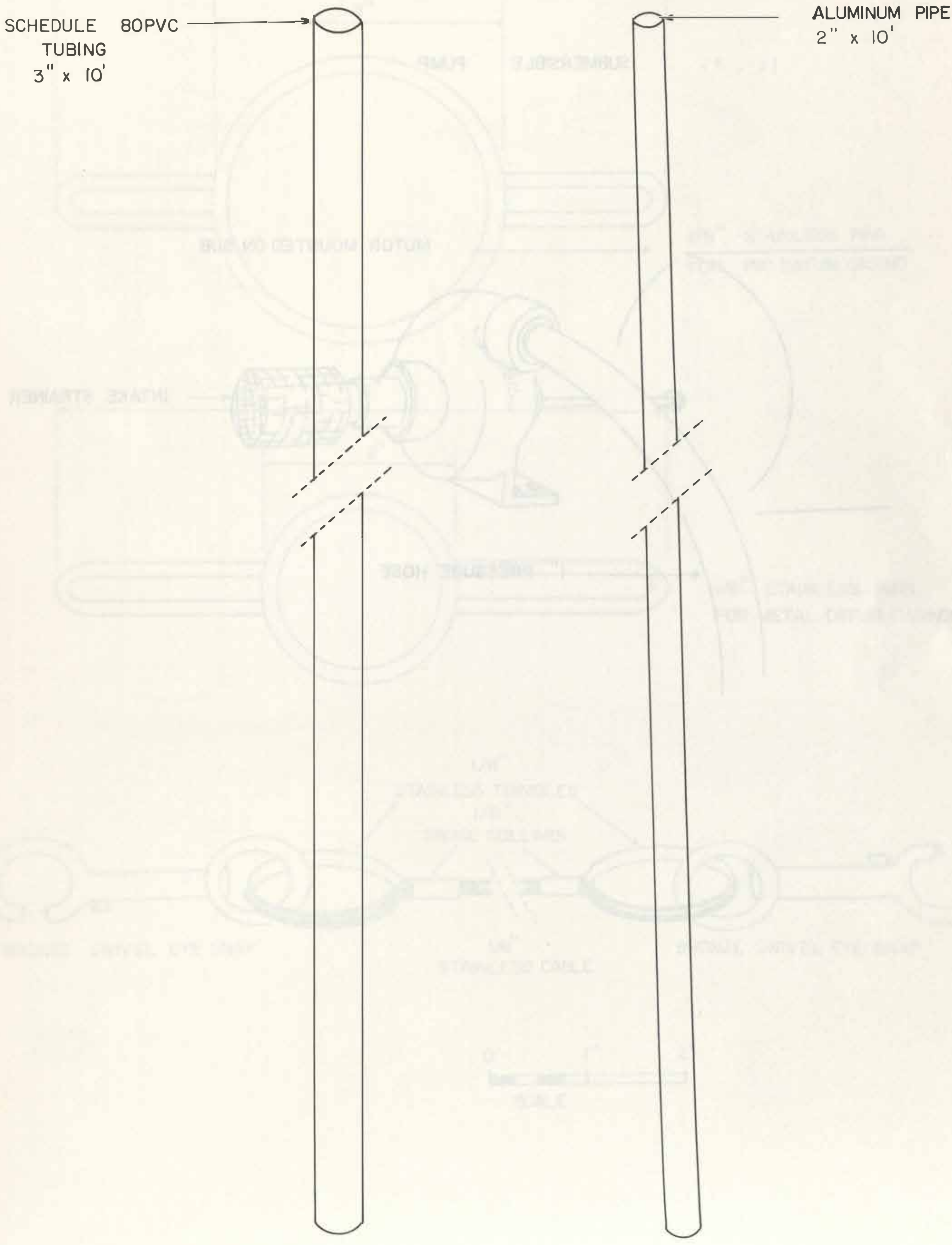


Fig. 15 SUBMERSIBLE PUMP

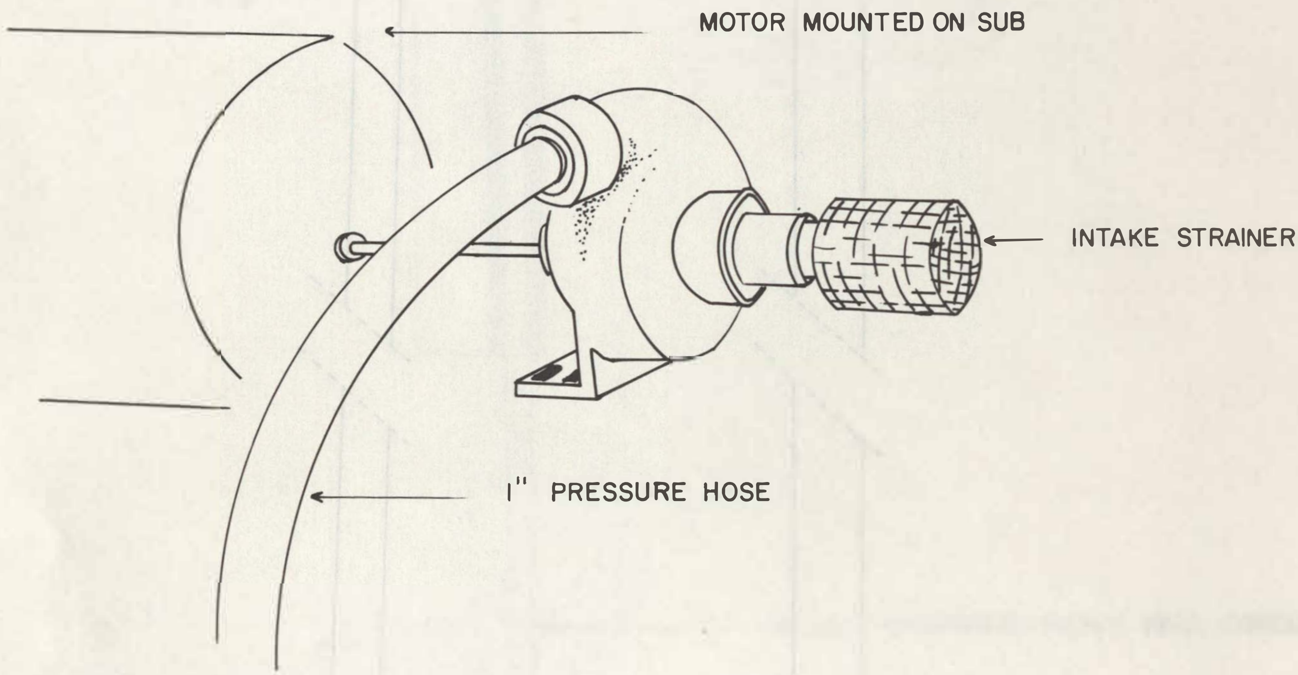


Fig. 14

DATUM HARNESS

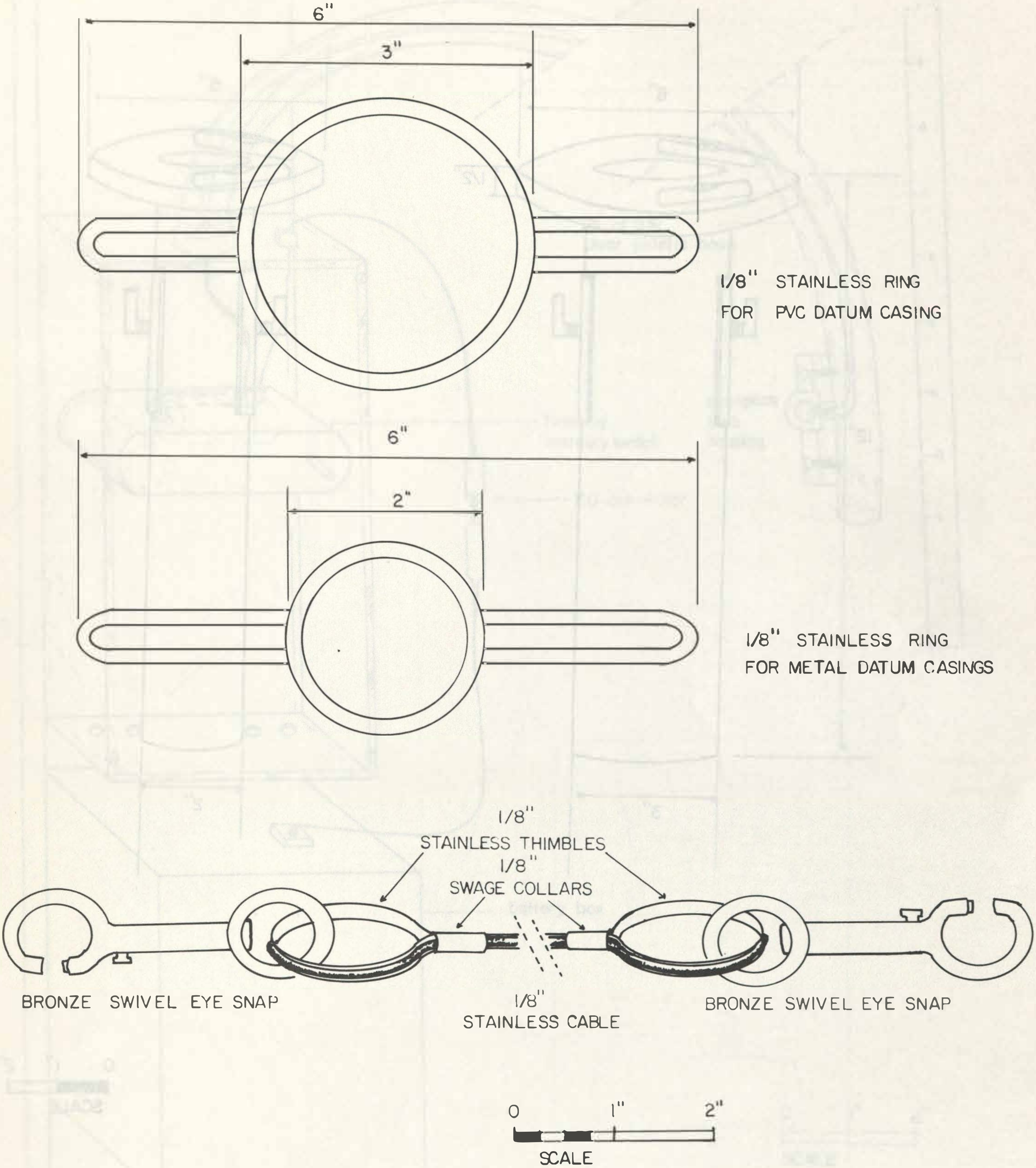
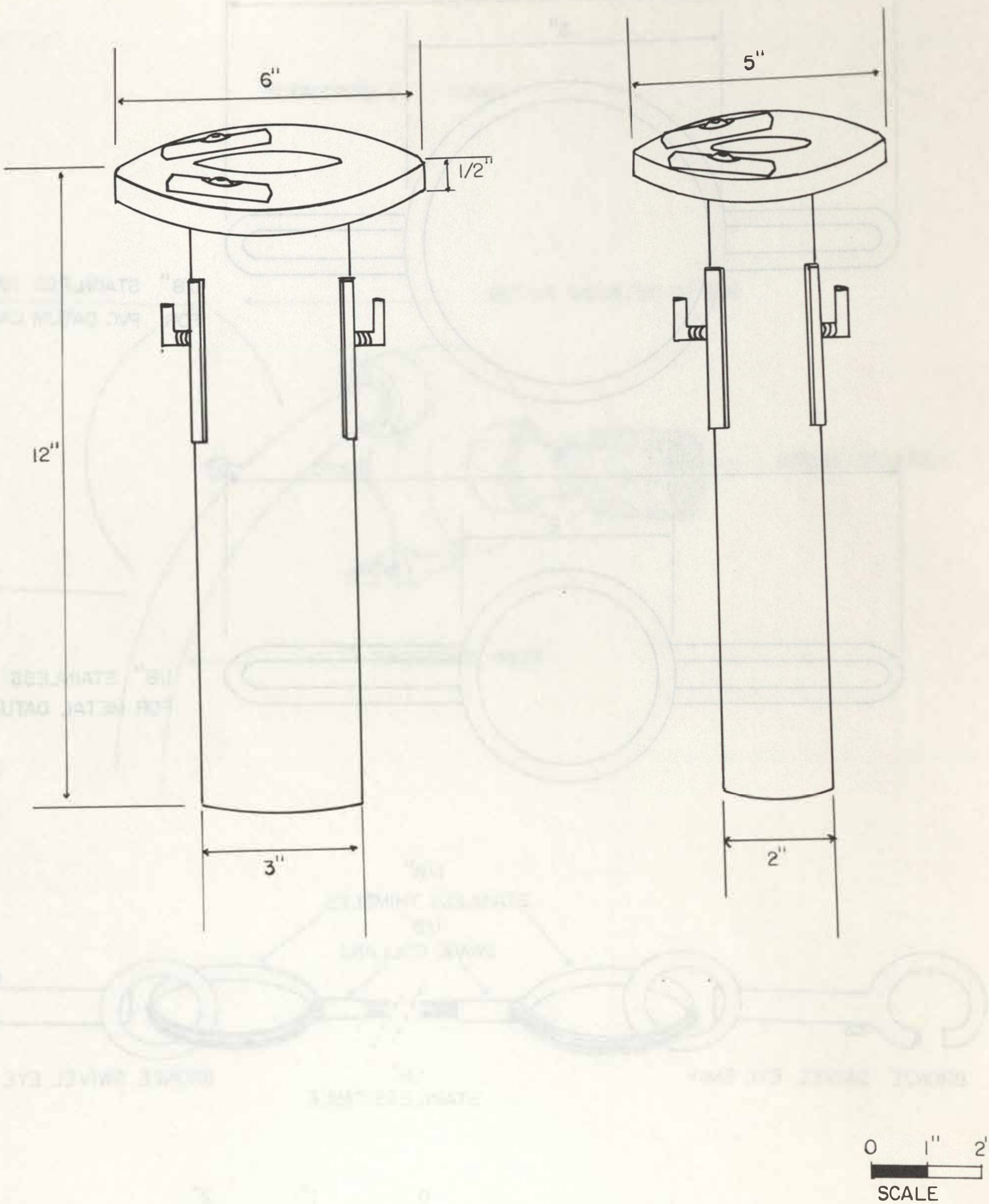


Fig. 15 DATUM CASING LEVELS



BUBBLE TUBE LEVEL WITH ELECTRONIC INDICATOR Fig. 16

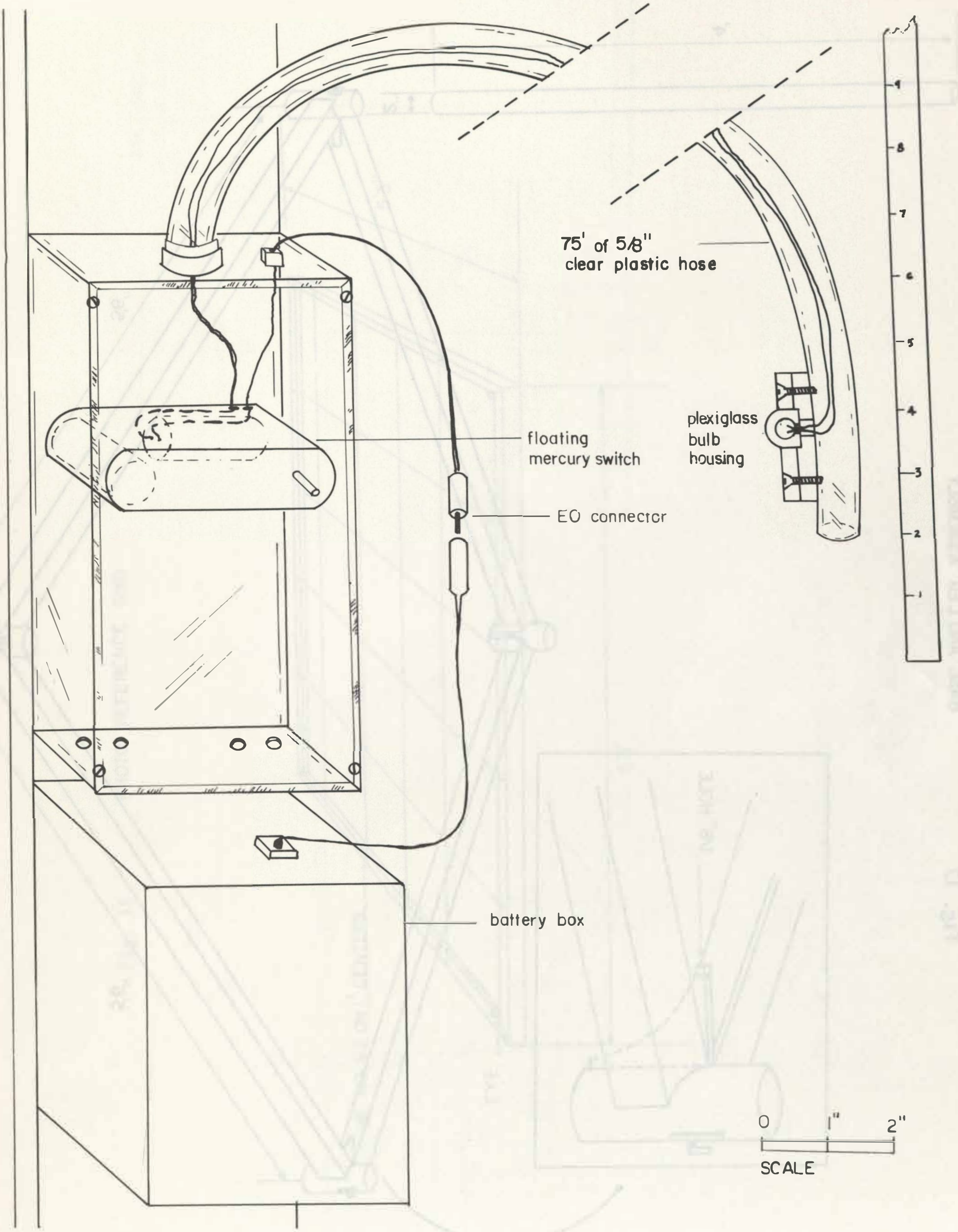


Fig. 17 BASE AND LEG ASSEMBLY

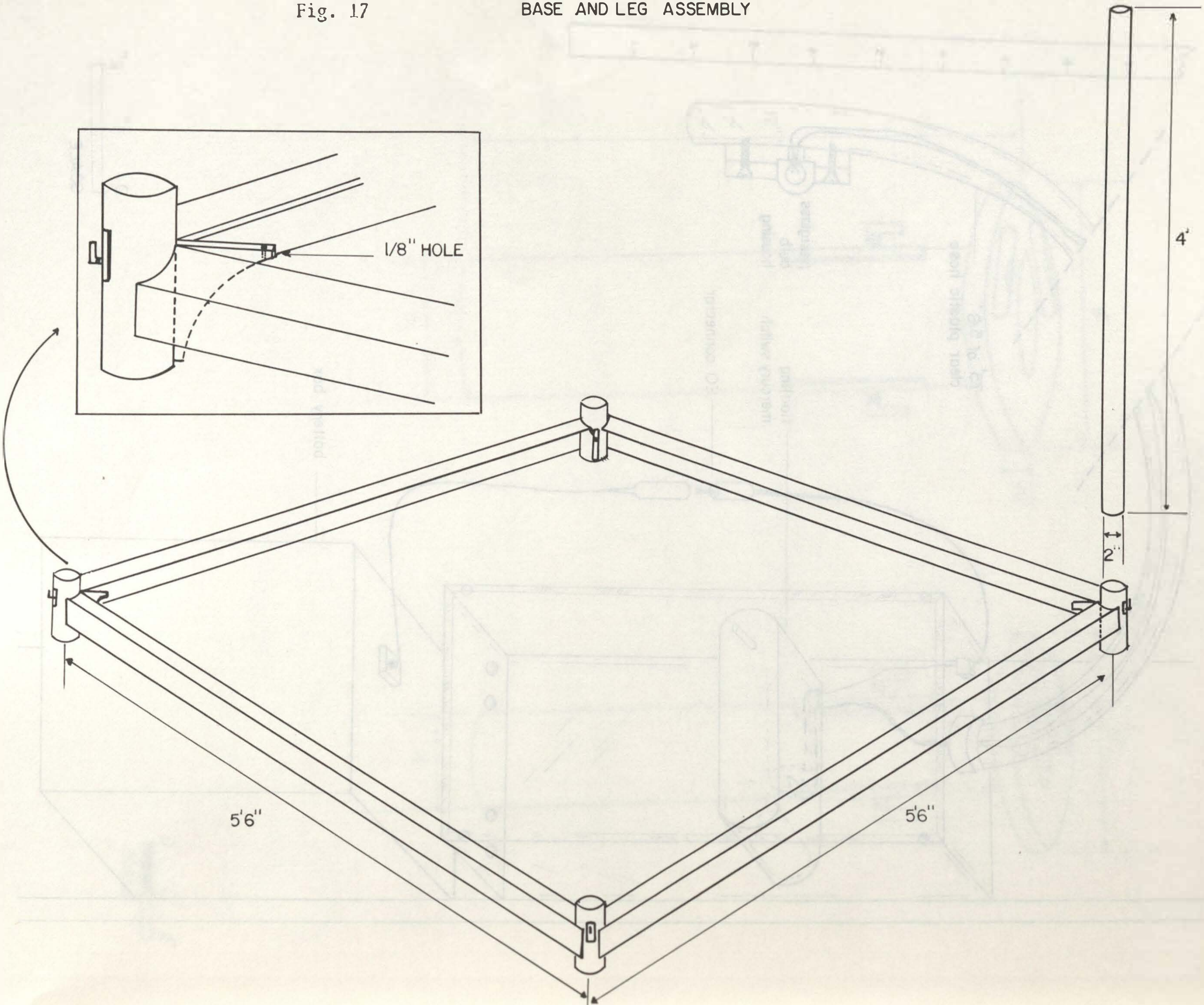


Fig. 18 PHOTO REFERENCE GRID

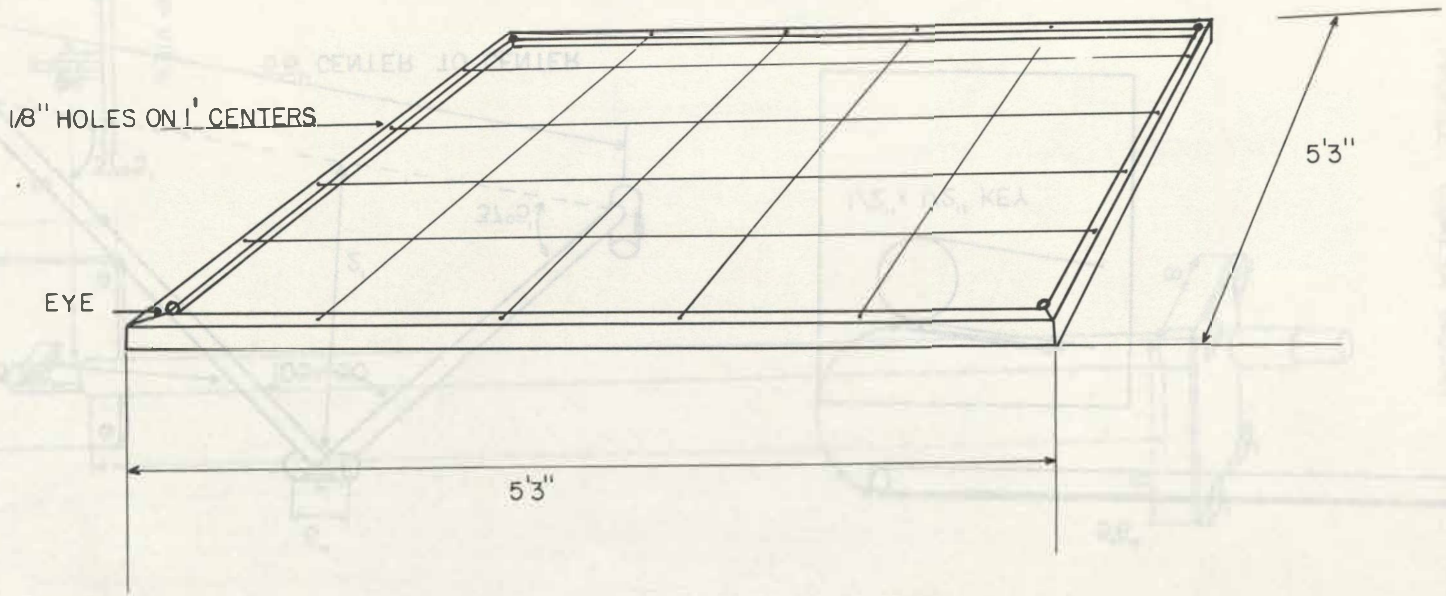


Fig. 19 CAMERA ATTATCHMENT FRAME

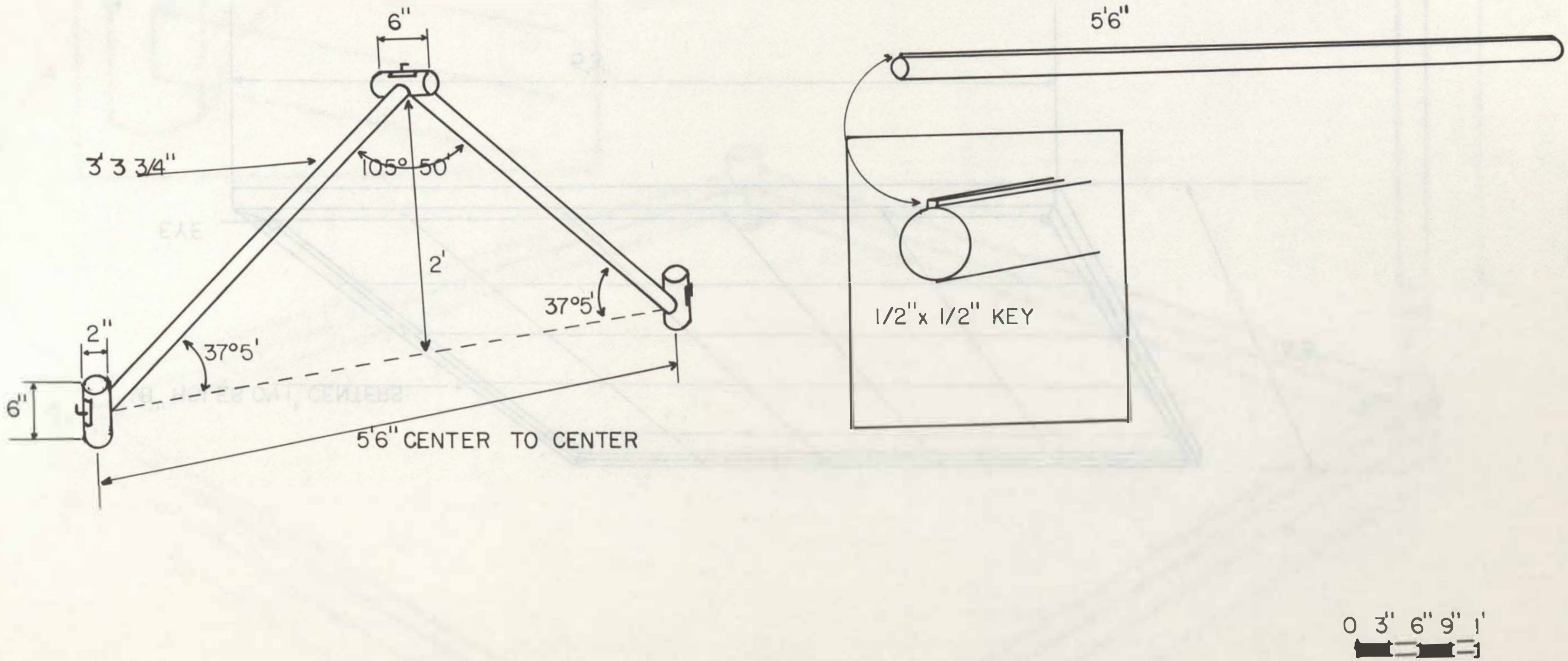


Fig. 20 PROFILE CAMERA MOUNT

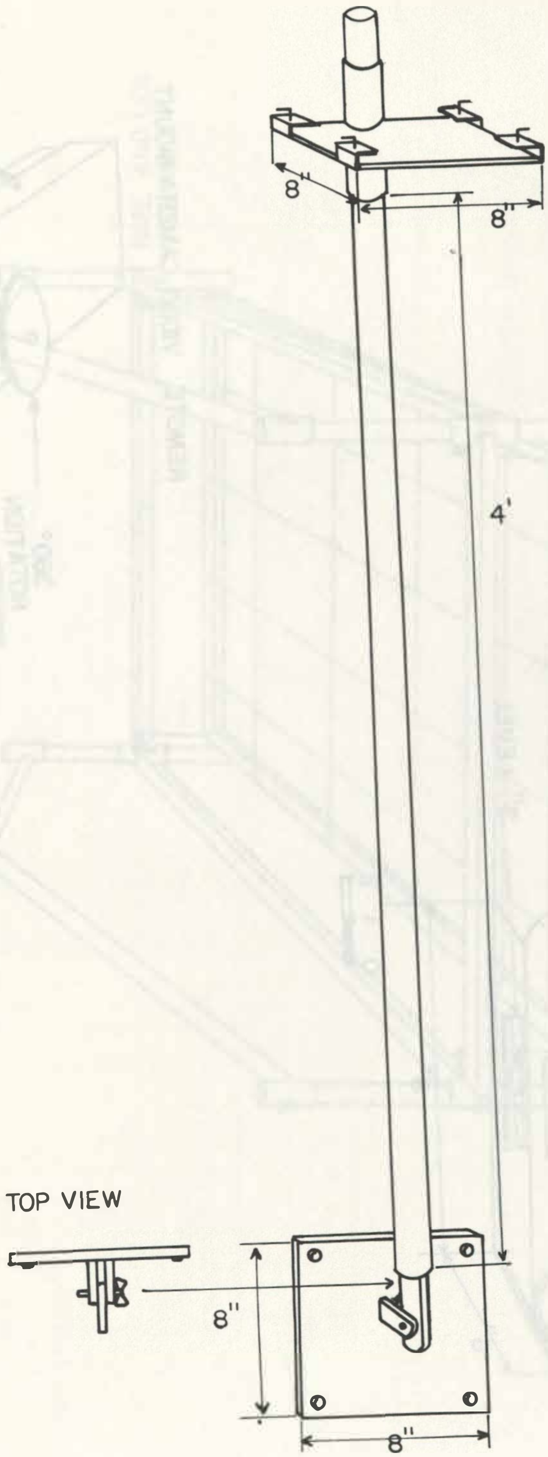


Fig. 21 CAMERA MOUNTS

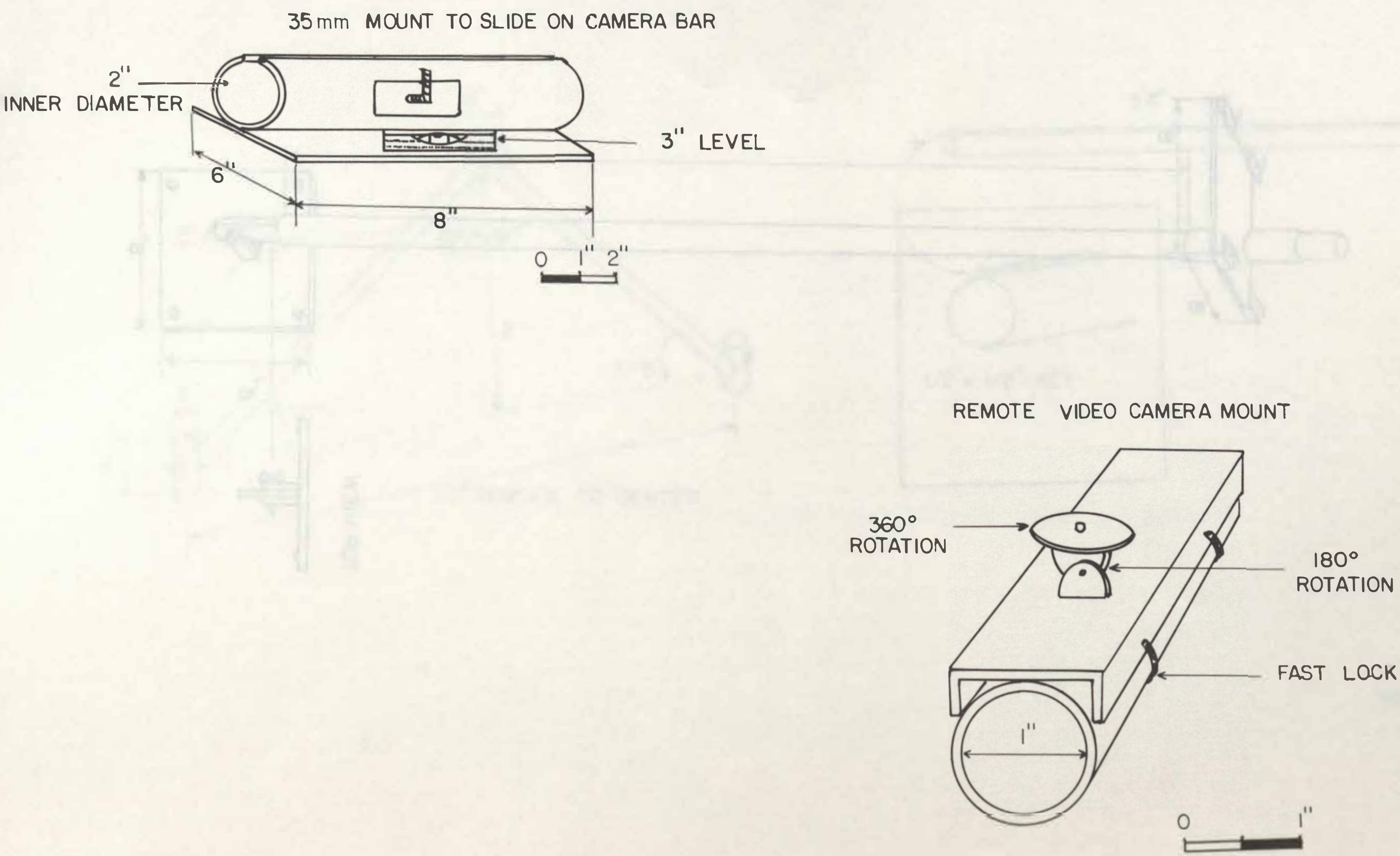


Fig. 22 PORTABLE GRID SQUARE AND CAMERA MOUNT

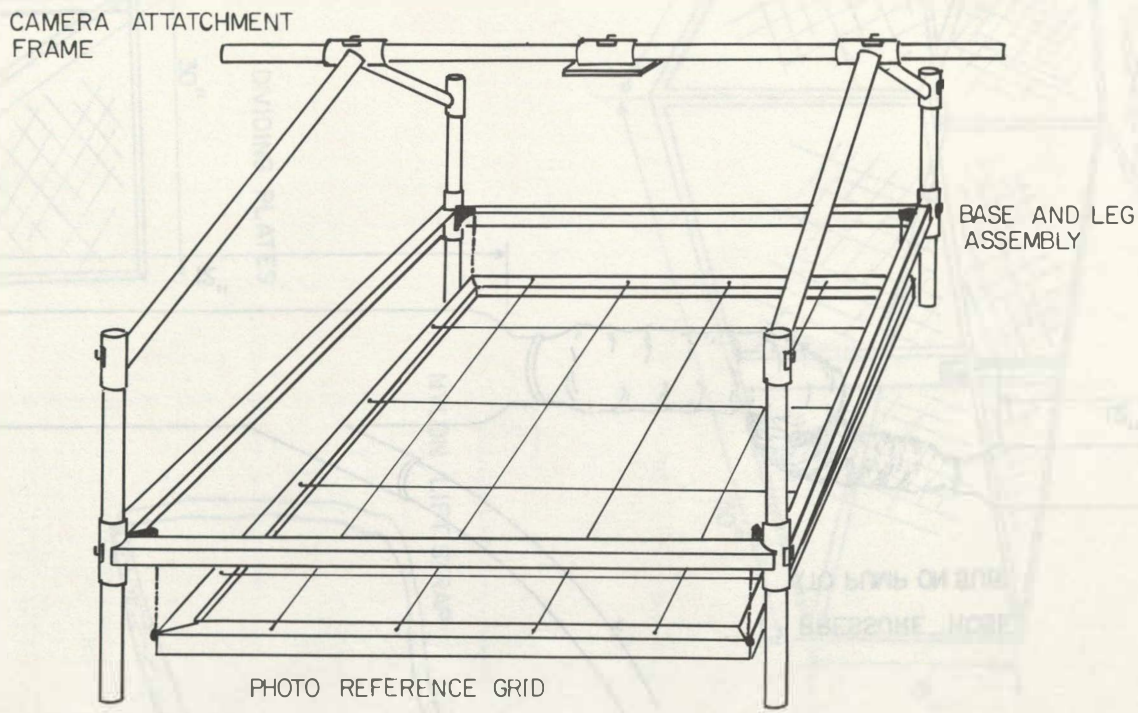


Fig. 23 INDUCTION DREDGE

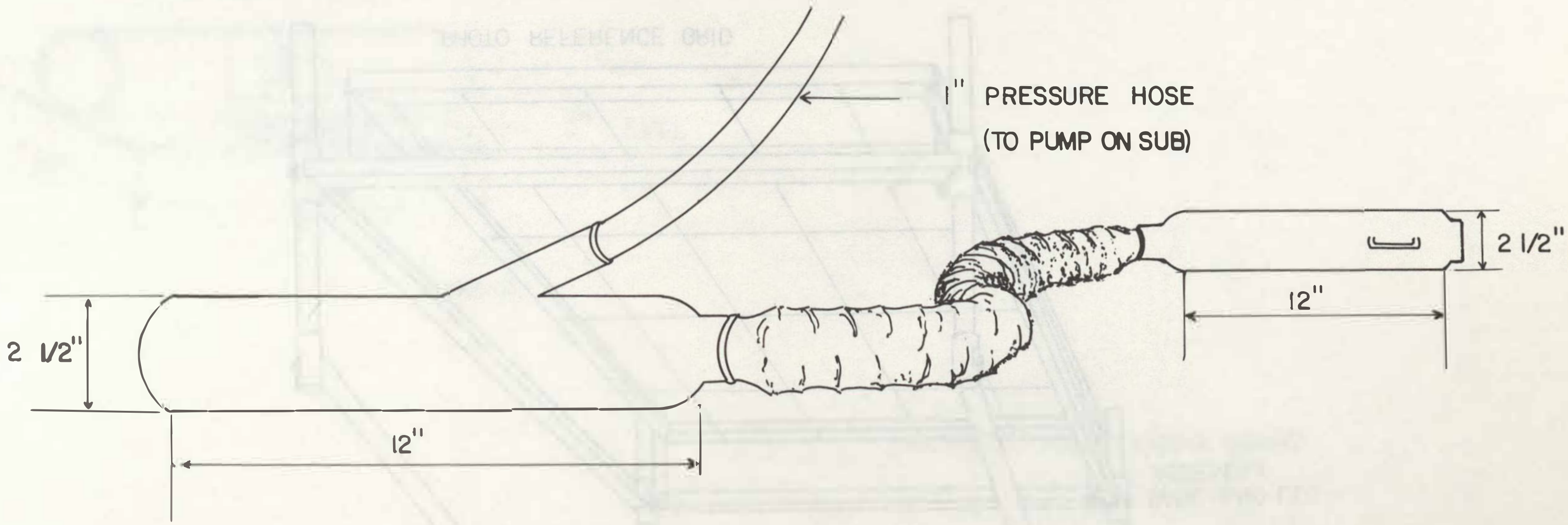


Fig. 24 RECOVERY BASKETS

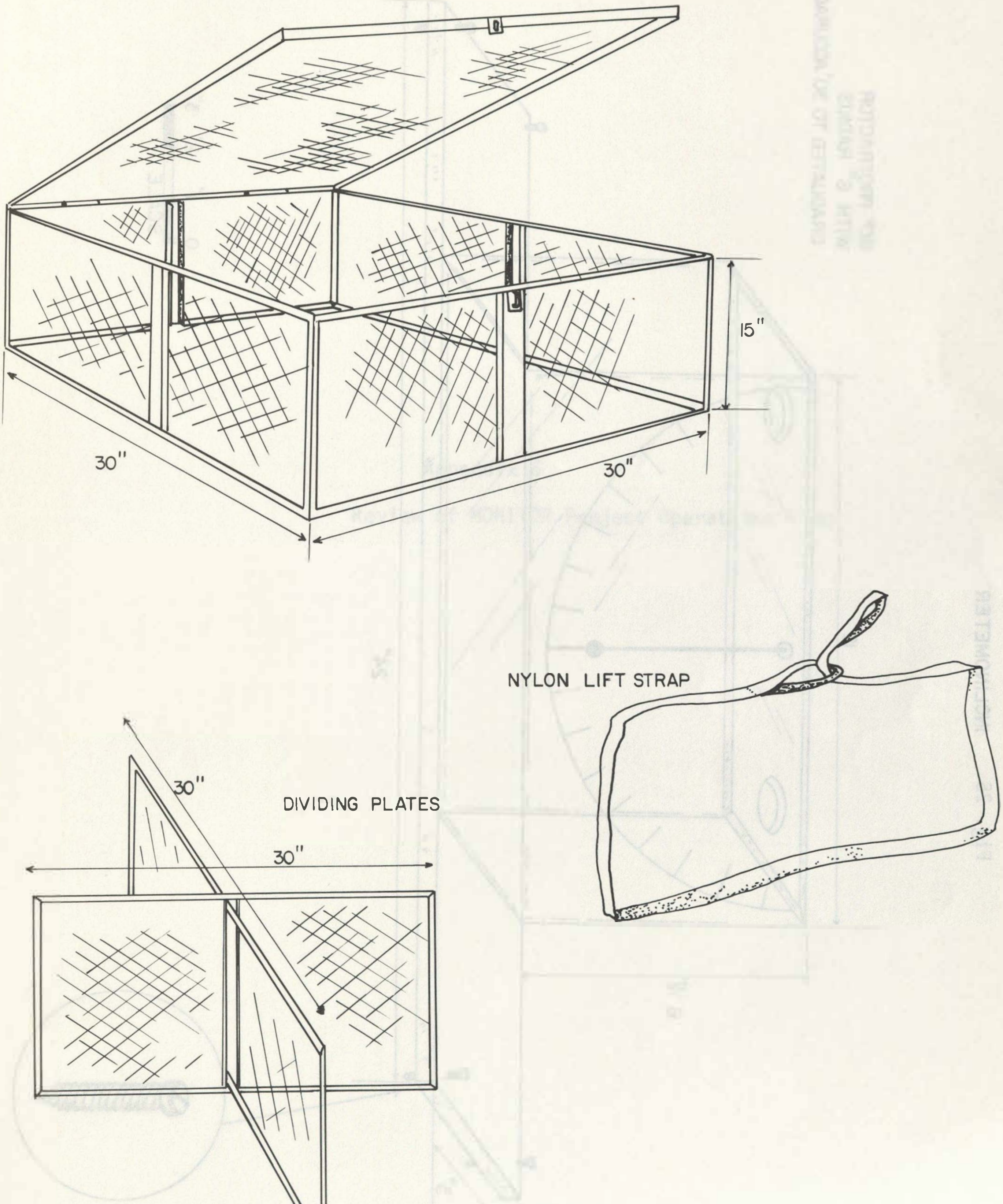
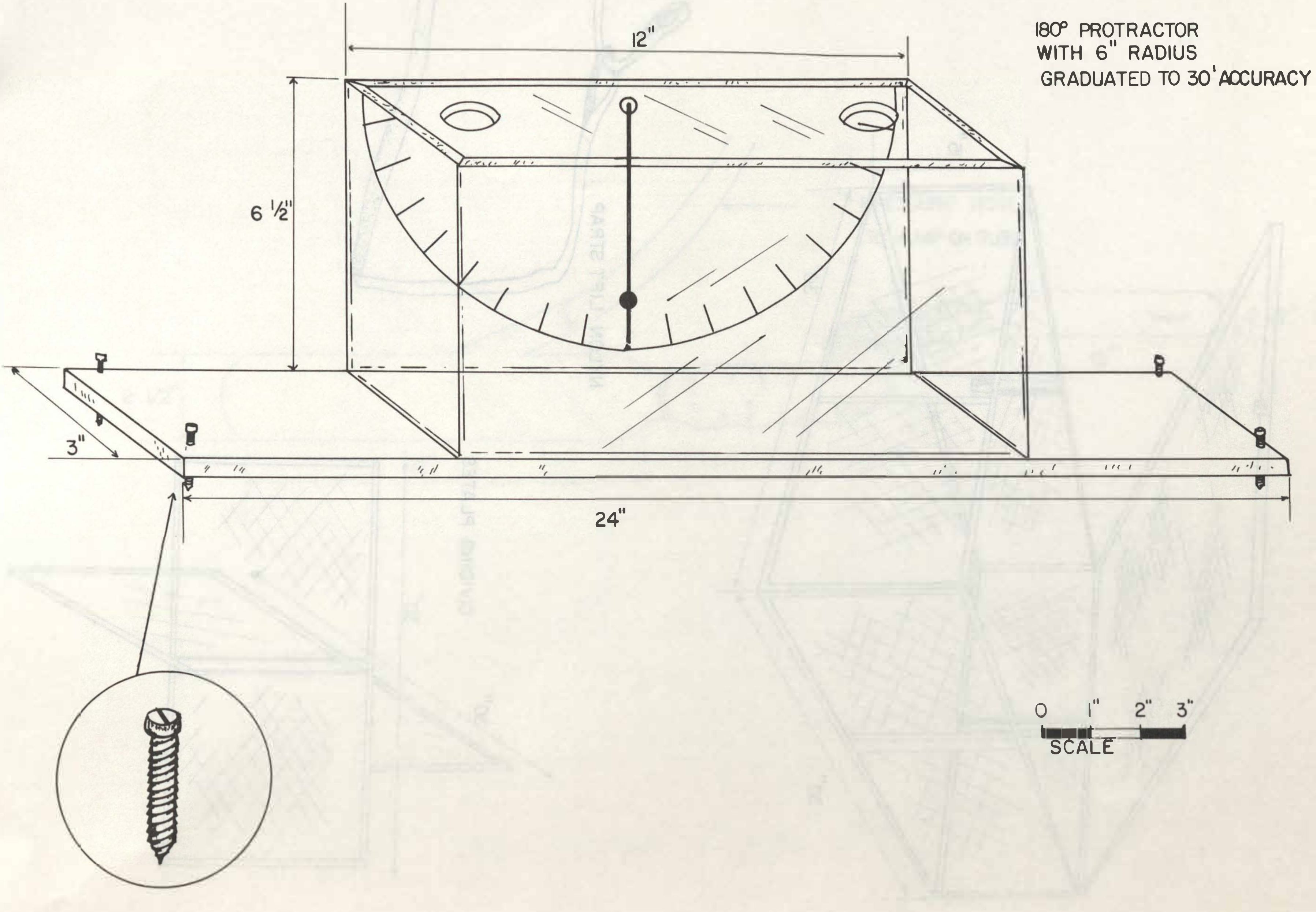


Fig. 25 INCLINOMETER



Appendix 6

Review of MONITOR Project Operations Plan

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SURVEY
Rockville, Md. 20852

OA/C71/FTS/2032

JUN 1 1979

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OFFICE OF OCEAN ENG.

TO: RD/OE - S. N. Anastasion

FROM: OA/C7 - H. R. Lippold, Jr.

SUBJECT: Review of Monitor Project Operations Plan

We have reviewed the operations plan for the proposed work at the Monitor site in August 1979. Although NOAA will not be funding the operation of the surface support vessels and clearance for charter is not required, the operation does involve NOAA personnel working on non-NOAA vessels and as such will require NOAA approval. We have established some preliminary safety guidelines for the use of uninspected non-NOAA vessels. A copy of these guidelines is attached. At this time, our information on the JOHNSON, SEA DIVER, and SEA GUARDIAN is derived from the Monitor site plan and firsthand reports from personnel who have observed the vessels. Based on this information, the vessels appear to be safe and seaworthy for the project use. In addition, the operations plan includes the necessary elements associated with operational safety to provide that safeguard.

The use of the NOAA Vessel LAIDLY for carrying official visitors to and from the Monitor site is approved provided the vessel inadequacies which were indicated in the April 1979 vessel inspection are corrected and provided the vessel carries lifesaving equipment and a liferaft with sufficient capacity for the crew and passengers. In addition, authority to grant approval for carrying non-Government personnel on NOAA vessels will be required. The NOAA program coordinator should approve all passengers prior to their embarking on the trip.

APPENDIX 6

Preliminary Guidelines for Evaluating Uninspected Vessels (Non-Government)

1. Is the vessel registered or documented with the U.S. Coast Guard or state government as being in the trade for which it is being used? e.g., oceanographic research vessel, fishing vessel, water taxi, etc.

2. Is the vessel insured and what type of insurance does it carry?

3. What is the history of this vessel's operation?

4. Is the vessel manned by experienced operators?

5. What is the safety record of the vessel?

6. What is the material condition of the vessel?

7. Does the vessel have adequate lifesaving and firefighting equipment?

8. Does the vessel have adequate communications for the operating area?

9. Is there an operational plan which defines the work area and the vessel's schedule?

10. Is there shore support personnel who know the schedule of the vessel and their operating area and who will know when the vessel is overdue?

11. Will there be a list of the vessel complement and passengers that is up to date and correct at all times?

12. Are there rescue facilities in the area adequate for the occasion and the vessel?

APPENDIX 6