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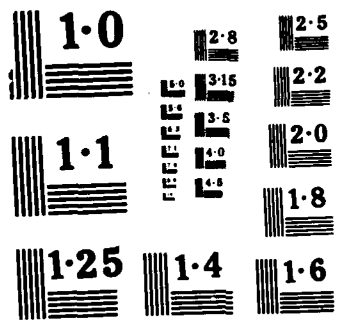

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PROJECT EXECUTION PLAN
FOR 1978 SQUAW MOORING

~~Volume 1~~

2

PROJECT EXECUTION PLAN
FOR 1978 SQUAW MOORING

FPO-1-78(7)
JUNE 1978 SEPT 1978

OCEAN FACILITIES ENGINEERING AND CONSTRUCTION PROJECT OFFICE
CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
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In January 1977, the Chesapeake Division, Naval Facilities Engineering Command (CHESNAVFACENGCOM) was tasked by the Public Works Center (PWC), San Diego to reinstall the sonar target SQUAW. The SQUAW is a 134.6 foot long 409 ton model experimental submarine hull which has been used by the U.S. Navy (Con't)

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since 1959 as a sonar target in various locations off San Diego, California.

The SQUAW will be remoored 300 feet below the ocean surface in approximately 6240 feet of water at a location about 42 miles southwest of San Diego. Installation is scheduled for the last week of June 1978.

CHESNAVFACENGCOM has provided the necessary engineering, the mooring analysis, the site survey, corrosion analysis, the ballasting experiment and analysis, equipment acquisition (including wire rope and equipment valued at over $80,000 on loan from CHESNAVFACNENGCOM's Ocean Construction Equipment Inventory), and overall Project Management, etc. Through the Naval Sea Systems Command, Supervisor of Salvage, CHESNAVFACENGCOM has contracted with Crowley Maritime Corporation to provide the vessels and personnel to perform the actual at-sea mooring installation. PWC, San Diego has assisted with services to outfit the SQUAW and provide and fabricate the necessary mooring components.

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1.0 PROJECT DESCRIPTION

1.1 SUMMARY

In January 1977, the Chesapeake Division, Naval Facilities Engineering Command ~~(CHESNAVFACENGCOM)~~ was tasked by the Public Works Center (PWC), San Diego to reinstall the sonar target *SQUAW*. The *SQUAW* is a 134.6-foot long 409-ton model experimental submarine hull which has been used by the U. S. Navy since 1959 as a sonar target in various locations off San Diego, California.

This report contains the plans for mooring

The *SQUAW* ~~will be remoored~~ 300 feet below the ocean surface in approximately 6240 feet of water at a location about 42 miles southwest of San Diego. Installation is scheduled for the last week of June 1978.

CHESNAVFACENGCOM has provided the necessary engineering, the mooring analysis, the site survey, corrosion analysis, the ballasting experiment and analysis, equipment acquisition (including wire rope and equipment valued at over $80,000 on loan from CHESNAVFACENGCOM's Ocean Construction Equipment Inventory), and overall Project Management, etc. Through the Naval Sea Systems Command, Supervisor of Salvage, CHESNAVFACENGCOM has contracted with Crowley Maritime Corporation to provide the vessels and personnel to perform the actual at-sea mooring installation. PWC, San Diego has assisted with services to outfit the *SQUAW* and to provide and fabricate necessary mooring components.

1.2 SQUAW BACKGROUND INFORMATION

The *SQUAW* was built in the early 1950's at the Long Beach Naval Shipyard. It was used by the Navy in the mid-1950's in the South Pacific as a structural target in underwater atomic tests. Since 1959, the *SQUAW* has been used as a sonar training device under control of Commander, Training Force Pacific (COMTRAPAC), San Diego. The *SQUAW* has been moored below the surface at three different locations off San Diego. In each case mooring component failures have caused the submarine to surface after an average installation period of five years.

The table below summarizes the *SQUAW* (sonar target) mooring installations, length of submergence and reasons for mooring failures.

SQUAW INSTALLATIONS

INST	MOOR FAILED	FAILURE MODE	WATER DEPTH	DEPTH BELOW SURFACE
1959	1964	STERN PADEYE	6000'	200'
1965	1970	MOORING LINES &/OR FITTINGS	3600'	200'
1970	1975/6	MOORING LINES &/OR FITTINGS	3500'	300'
1978	-------	-------------	6240'	300'

1.3 THE SQUAW SUBMARINE

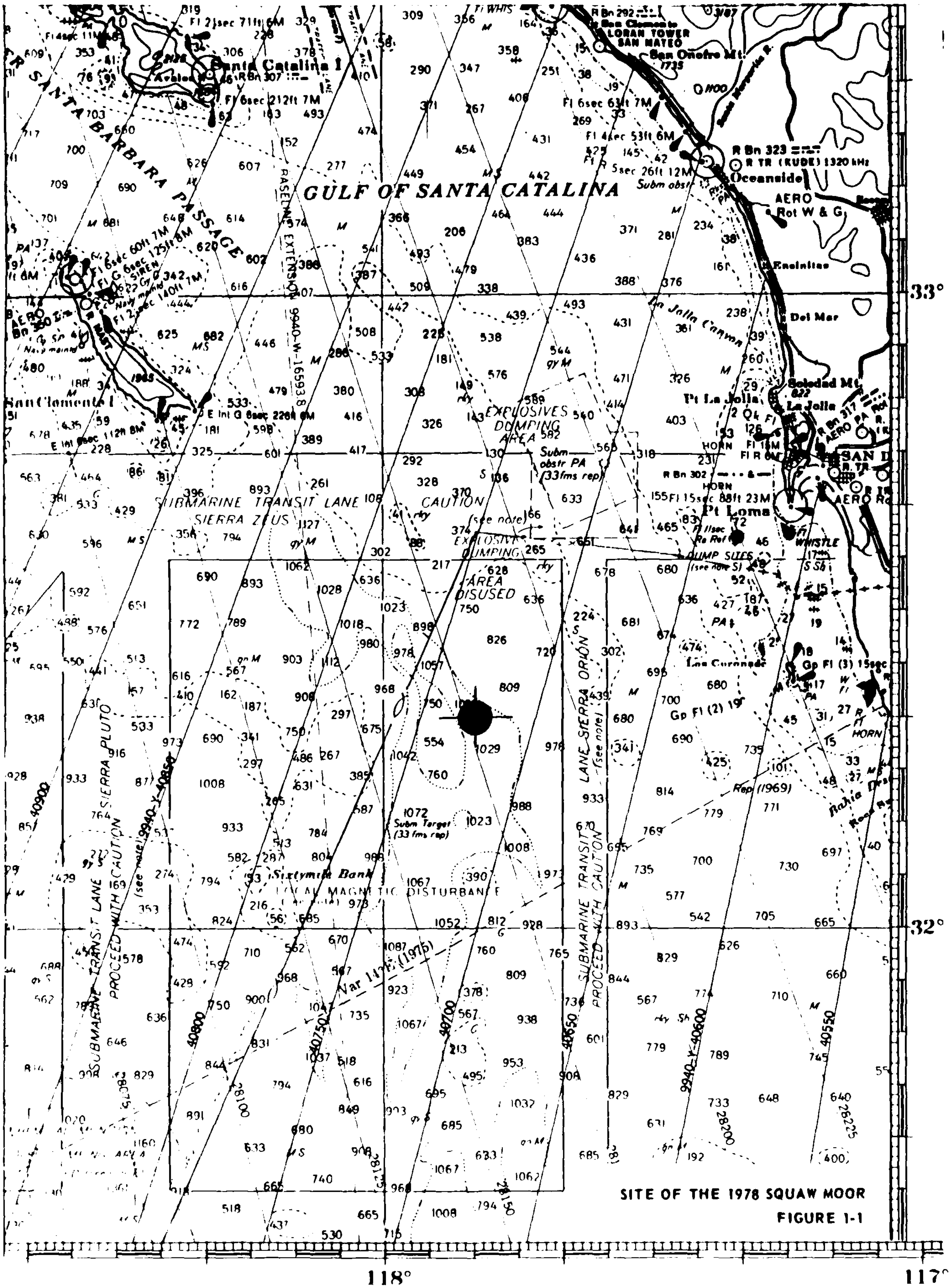
The *SQUAW* was refurbished at the U. S. Naval Shipyard, Long Beach, California in October 1976. Since then, it has been alongside Pier 13 at the U. S. Naval Station, San Diego under the cognizance of the Public Works Center. CHESNAVFACENGCOM has obtained a limited amount of prints and documents pertaining to the 1976 shipyard refurbishment.

The buoyancy and trim tests, and the *SQUAW* outfitting and preparation for remooring were carried out by PWC and CHESNAVFACENGCOM. These procedures required that the inner and outer structural hull hatch covers (bow and stern) be removed and replaced. These tests affected only the forward and after trim tanks and the external ballast tanks, and not the main pressure hull of the submarine. Air pressure tests were performed successfully on the bow and stern inner hatch covers subsequent to each "closure".

These tests and preparations, and all planning and outfitting for the *SQUAW* remooring have been accomplished with the understanding that the interior hull is capable of withstanding the rigors of the tow out to the site, the installation, and the period for which it is expected to be submerged to a depth of possibly 350 feet.

1.4 SITE LOCATION/NAVIGATIONAL EQUIPMENT

The *SQUAW* will be moored at a location 32° 20' North Latitude and 117° 50' West Longitude, Figure 1-1. Tolerances for the installation require that the *SQUAW* be located within one-half mile of the designated site location.



SITE OF THE 1978 SQUAW MOOR

FIGURE 1-1

Depth tolerances are: 300 feet below the ocean surface plus or minus 50 feet.

Approximate distances from the site to:

San Diego 42 nautical miles
Point Loma 31 nautical miles
San Clemente Island (eastern tip) 34 nautical miles

Navigation will be accomplished by use of extended range Motorola Mini-Ranger equipment. These units, with proper height, can achieve accurate range data at distances of 100 miles or more. Navigational Services Inc., a subsidiary of Lewis & Lewis, Ventura, California is under contract to Crowley Maritime Corporation to provide the following services.

- Aboard Installation Vessel (*M/V MANATI*); install Mini-Ranger console, Omni-directional receiving antenna, x-y or latitude-longitude visual and tape readout, and automatic plotting gear, plus navigator to operate and maintain system and equipment.
- At shore sites on San Clemente Island, in hills behind San Diego (and possibly a third location due north in the San Mateo/San Clemente mainland area), install unmanned transponders supplied with electrical power by propane thermo-electric generators.
- The navigator will insure that a continuous record and plot of the operation is maintained, providing the necessary offset correction between the receiver antenna and the stern of the installation vessel.

A LORAN-C unit aboard the Crowley support tug will be utilized in the event the Mini-Ranger fails to operate properly. At best, off the coast of San Diego, the LORAN-C network will provide accuracy of plus or minus 1/4 mile as compared to plus or minus 10 meters for the Mini-Ranger.

A Ratheon Corp. No. 741 precision depth recorder will be placed on the installation vessel to verify the water depth at the installation site. The unit will have a retractable transducer amidships with a depth range of 1370 fathoms (8220 ft.).

1.5 INSTALLATION VESSELS

The *Motor Vessel MANATI* is an offshore workboat type vessel with all the superstructure forward leaving extensive open deck area aft. Principal dimensions are as follows:

Length 195'
Beam 53'
Depth 14.6'
Draft 10' (approx.)
Gross Tonnage 450
Net Tonnage 306
Built 1970 Steel Construction
Fuel Capacity 98,000 Gallons
Fresh Water Capacity 10,000 Gallons
Lube Oil Capacity 500 Gallons
Marine Engines - Two (2) No. 399 Catepillar Diesels (Twin Screws) of 2300 Total Horsepower
Single Sideboard Radio
Decca RM 326 Radar
8 - 10 Man Crew
Open Deck approximately 120' x 50'

The *SUPPORT TUGBOAT* is a Crowley Maritime Corporation seagoing tug which will be utilized to tow the *SQUAW* to the installation site and will remain to support the operation.

1.6 OPERATIONS PLAN OUTLINE AND SCHEDULE

The detailed installation operations plan is presented in Section 4.0 herein. An outline of the project background and Project Operations Plan and Schedule is as follows:

- (About) Jan. 1976 - *SQUAW* Mooring Failed - *SQUAW* Surfaced
- Nov. 1976 - *SQUAW* Refurbished, Long Beach Naval Shipyard
- 23 Nov. 1976 - PWC, San Diego tasked by COMTRAPAC to proceed with *SQUAW* remooring
- 22 Dec. 1976 - Preliminary contacts and request for estimates from PWC to CHESNAVFACENGCOM regarding *SQUAW* remooring

- 2 Feb. 1977 - Initial tasking and funding for CHESNAVFACENGCOM to commence with *SQUAW* mooring design and procurements
- Week of 25 July 1977 - At-sea survey of *SQUAW* mooring site
- 12 Sept. 1977 - Analysis by CEL of cores taken during site survey
- 23 Sept. 1977 - CEL dynamic analysis of *SQUAW* deployment
- 3 Jan. 1978 - *Major* Procurement Contract, U. S. Steel Corp. for wire rope mooring legs
- 23 Jan. 1978 - Trim and ballasting test on *SQUAW*
- 10 May 1978 - Pre-contract meeting, Crowley, San Francisco office
- 30 May 1978 - Commence *SQUAW* outfitting by PWC, San Diego and CHESNAVFACENGCOM
- 19 June 1978 - Crowley commence outfitting and loading *M/V MANATI* in Oakland, Calif. in preparation for *SQUAW* installation
- 23 June 1978 - *M/V MANATI* transit to San Diego
- 25 June 1978 - Load and prepare all final equipment on *M/V MANATI*
- 26 June 1978 - Crowley tug with *SQUAW* in tow and *M/V MANATI* transit to installation site
- 27 June 1978 - Commence *SQUAW* moor installation
- 30 June 1978 - Installation complete; transit to San Diego
- 1 July 1978 - Demobilization, offloading of *M/V MANATI*
- 15 Aug. 1978 - Project Completion Report

2.0 ORGANIZATIONAL RESPONSIBILITIES AND INTERFACES

2.1 ORGANIZATIONAL STRUCTURE

SQUAW program funding and direction has been provided by CINCPACFLT to the user agency COMTRAPAC. Utilization of *SQUAW* as a sonar target is under the control of TRAPAC. PWC, San Diego was tasked to reinstall the *SQUAW* moor. CHESNAVFACENGCOM, in turn, was tasked with the responsibility for carrying out the actual installation.

For contractual expediency, an existing contract between COMNAVSEASYSCOM (SUPSALV) and Crowley Maritime Corporation, San Francisco has been utilized by CHESNAVFACENGCOM to provide the necessary vessels and personnel to perform the

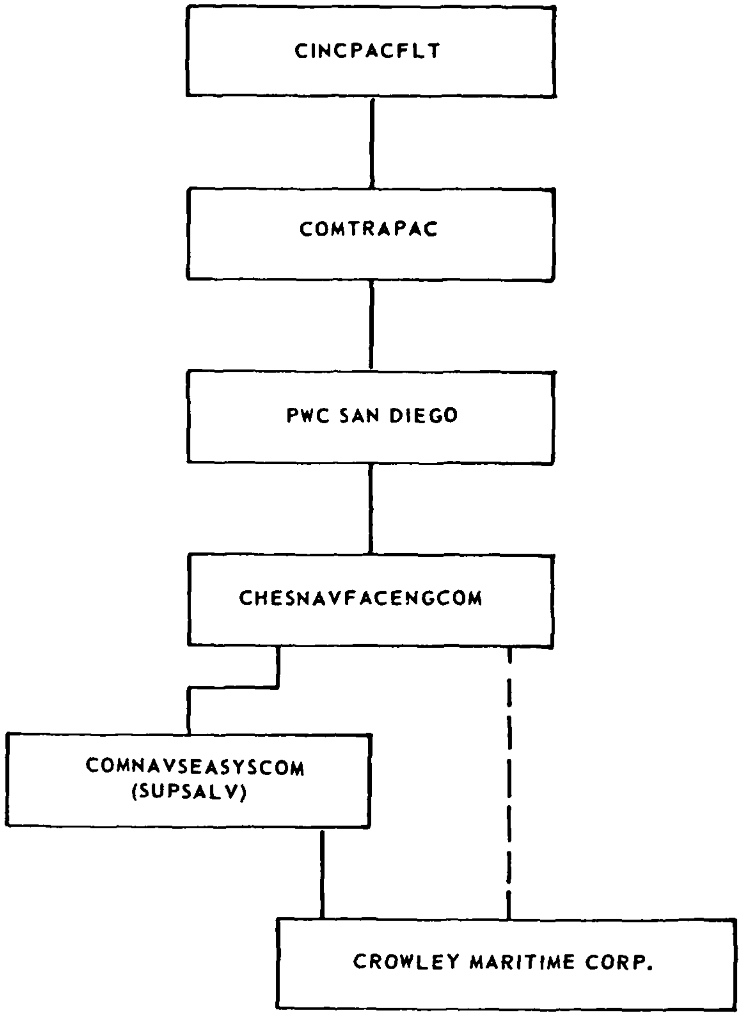


FIGURE 2-1

installation. The original plan, an all Navy installation utilizing ATF's and personnel from COMNAVSURFPAC and CONSERVRON ONE, was dropped due to a lack of available vessels.

This organizational structure is illustrated in Figure 2-1.

2.2 ORGANIZATIONAL RESPONSIBILITIES

Organizational responsibilities and their interrelationships are shown graphically in Figure 2-2 and are delineated by organization below:

CHESNAVFACENGCOM

CHESNAVFACENGCOM has accepted the responsibility for the *SQUAW* moor reinstallation including all the associated tasks involved. The tasks and

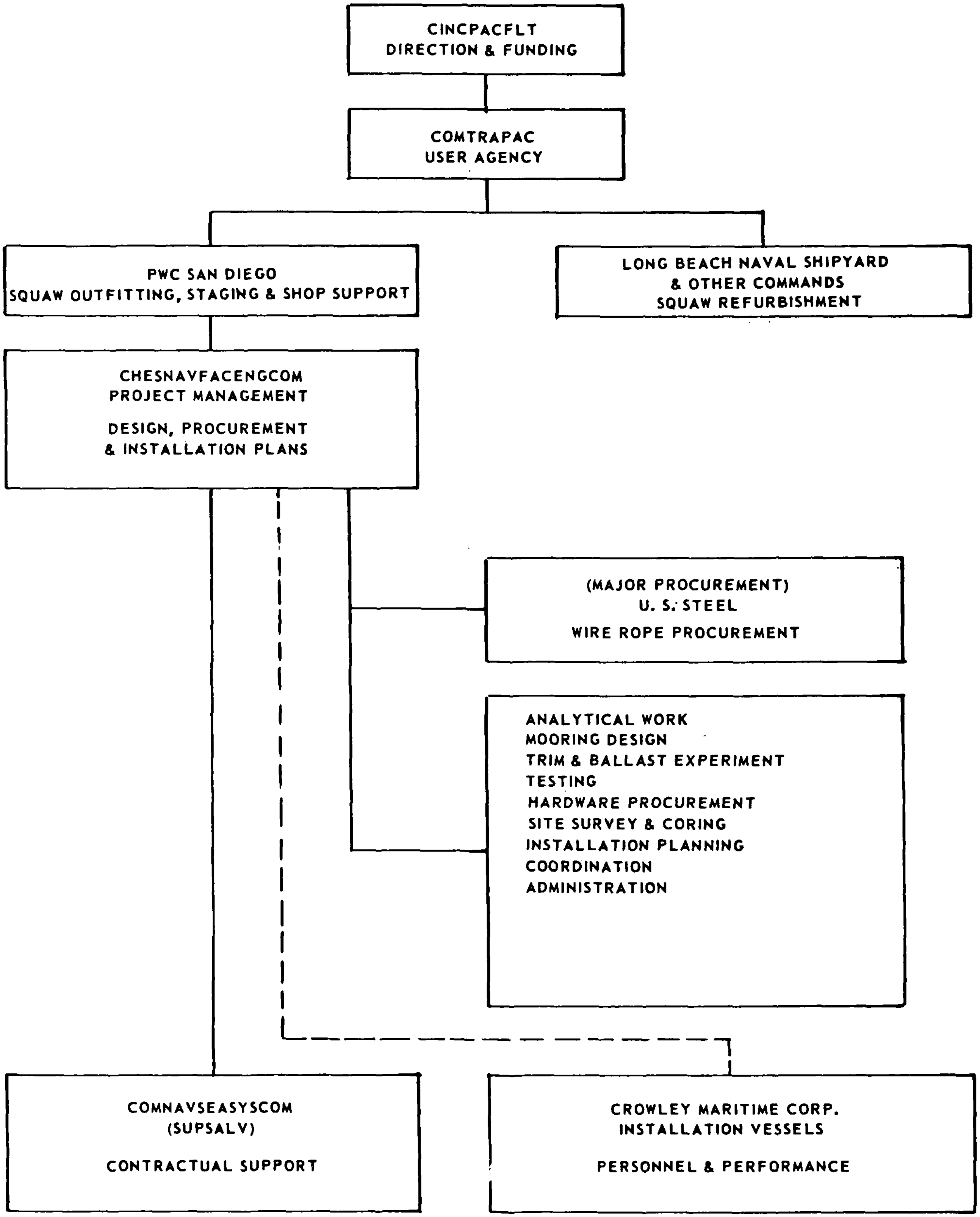

CINCPACFLT
DIRECTION & FUNDING
COMTRAPAC
USER AGENCY
PWC SAN DIEGO
SQUAW OUTFITTING, STAGING & SHOP SUPPORT
LONG BEACH NAVAL SHIPYARD
& OTHER COMMANDS
SQUAW REFURBISHMENT
CHESNAVFACENGCOM
PROJECT MANAGEMENT
DESIGN, PROCUREMENT
& INSTALLATION PLANS
(MAJOR PROCUREMENT)
U. S. STEEL
WIRE ROPE PROCUREMENT
ANALYTICAL WORK
MOORING DESIGN
TRIM & BALLAST EXPERIMENT
TESTING
HARDWARE PROCUREMENT
SITE SURVEY & CORING
INSTALLATION PLANNING
COORDINATION
ADMINISTRATION
COMNAVSEASYSCOM
(SUPSALV)
CONTRACTUAL SUPPORT
CROWLEY MARITIME CORP.
INSTALLATION VESSELS
PERSONNEL & PERFORMANCE

FIGURE 2-2

responsibilities of the other organizations involved, principally SUPSALV, PWC, and Crowley, emanated from, were coordinated by, CHESNAVFACENGCOM.

This Project Execution Plan provides an overview of the project as well as information necessary for the installation phase. It includes the brief operations plan as submitted by Crowley, Appendix G, which in turn had followed the sequential operations format recommended by CHESNAVFACENGCOM. The operations plan is expanded in detail in Section 4.0 of this Project Execution Plan.

The Project Execution Plan does not include all the analyses, engineering details, administrative and financial information, project sub-studies, schedule and milestone dates, interorganizational activities, etc. performed up to this time. This information, as well as an *as-built* report of the installation will be included as part of the Project Completion Report.

As stated previously, CHESNAVFACENGCOM has accepted the *SQUAW* submarine as is. All work done to or with the *SQUAW* by CHESNAVFACENGCOM is detailed herein.

COMNAVSEASYSCOM (SUPSALV)

During the period November 1977 through January 1978, COMSURVGRU, COMSURFPAC, and COMTHIRDFLT, in analyzing Navy assets available to install *SQUAW*, determined that these assets were not available and that CHESNAVFACENGCOM should accomplish the *SQUAW* remooring through SUPSALV "under aegis of his West Coast Salvage Contract". CINCPACFLT concurred, and has provided the necessary direction and funding.

As a result, SUPSALV has supported the CHESNAVFACENGCOM effort by providing contracting and interface services with the West Coast contractor, Crowley Maritime Corporation. Continued support by SUPSALV will be required in pursuing the project through to completion.

PWC, SAN DIEGO

PWC has maintained physical control of the *SQUAW* from the shipyard period in November 1976 to the present. Shop, shipyard facilities, and crane support have been provided by PWC during the site survey, trim and ballasting test, and the outfitting period. Upon completion of the outfitting and readiness period, the *SQUAW* and all associated installation equipment will be transferred to Crowley in San Diego. PWC may be required to provide additional support on a timely basis during the installation period and immediately afterwards for demobilization.

CROWLEY MARITIME CORPORATION

Crowley will perform the tasks required to accomplish the *SQUAW* moor installation in accordance with this Project Execution Plan, and contractually, in accordance with Task Order 0004 to the COMNAVSEASYSCOM Contracts N00024-76-A-2035, N00024-78-PR-00195. A copy of Task Order 0004 is included herein as Appendix D.

The task order cited, as well as the original request for quote to Crowley by SUPSALV, the Crowley reply, and the Crowley Operations Procedure summary have all addressed the basic requirements of the project and the end results to be achieved. No attempt has been made to identify all aspects, facets, contingencies, etc. of the job. This approach has been followed due to the complexity and variables associated with the installation. However, this Project Execution Plan has, in consultation with Crowley, identified most project execution functions in detail.

2.3 ORGANIZATIONAL INTERFACES

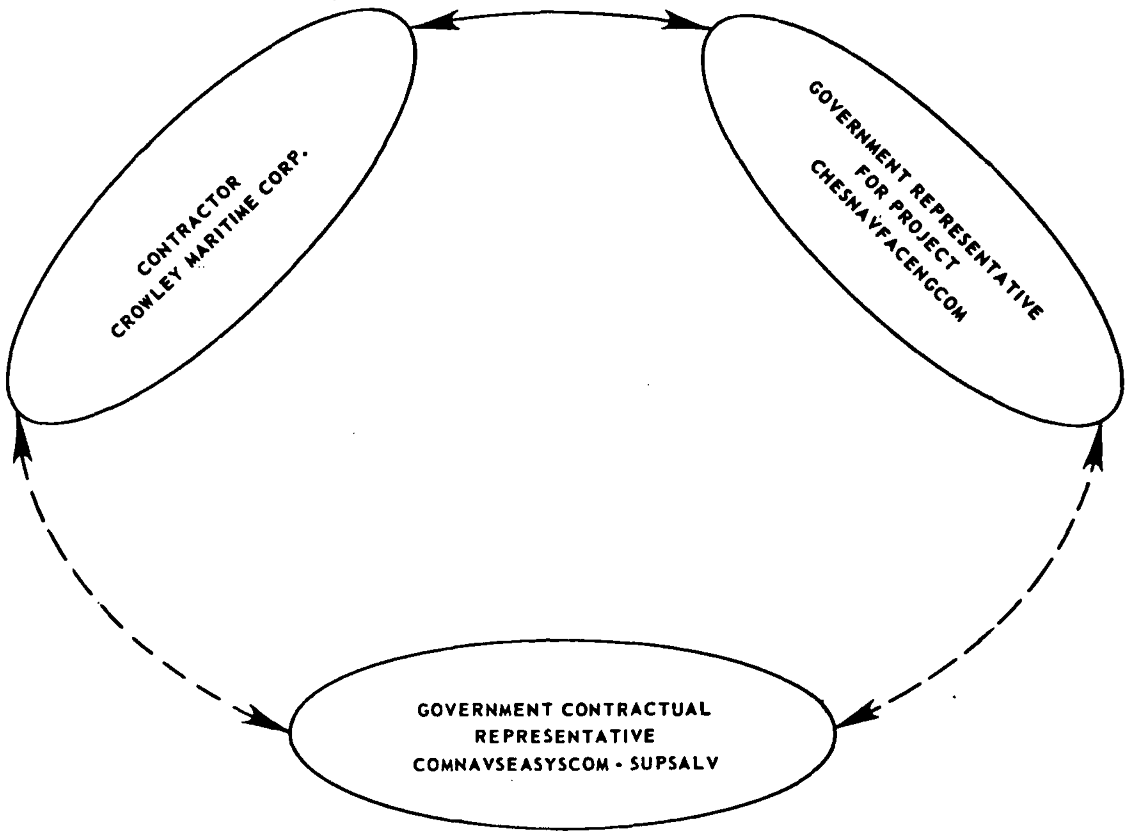
Organizational interfaces during the total operational activities associated with this project are shown graphically in Figure 2-3 and are delineated below.

PROJECT FORMULATION

Funding and project direction were provided by CINCPACFLT to COMTRAPAC to PWC, San Diego and to CHESNAVFACENGCOM for the engineering, testing, project studies, site survey, planning, etc. CHESNAVFACENGCOM requested certain services of PWC for later phases of the project.

CONTRACTUAL DETAILS

When the funding and tasking were completed or imminent, contact between CHESNAVFACENGCOM and SUPSALV ensued. CHESNAVFACENGCOM provided the technical guidance plus the Government estimates for the SUPSALV contract to Crowley Maritime Corporation.



SQUAW MOORING ORGANIZATIONAL STRUCTURE DURING
OUTFITTING, STAGING, INSTALLATION, AND DEMOBILIZATION

FIGURE 2-3

PROJECT PREPARATION AND STAGING

PWC and CHESNAVFACENGCOM were involved in the final preparation of the *SQUAW* and in obtaining Government supplied items for the project. Crowley was involved in the process of outfitting the installation vessel and in preparing personnel and equipment. CHESNAVFACENGCOM provided contact with PWC, and also functioned as Government Representative with the Crowley Maritime Corporation.

INSTALLATION OF SQUAW MOOR

Crowley Maritime Corporation is under contract to provide vessels, equipment, and personnel to perform the *SQUAW* moor installation. CHESNAVFAC-ENGCOM representatives are to be present at the installation to act as Government Representatives and to provide certain Government Furnished Equipment and services.

DEMOBILIZATION

CHESNAVFACENGCOM will coordinate demobilization activities with PWC and Crowley, with Crowley offloading all GFE at PWC for handling and forwarding as required.

3.0 SQUAW MOOR SYSTEM AND COMPONENTS

3.1 MOORING SYSTEM

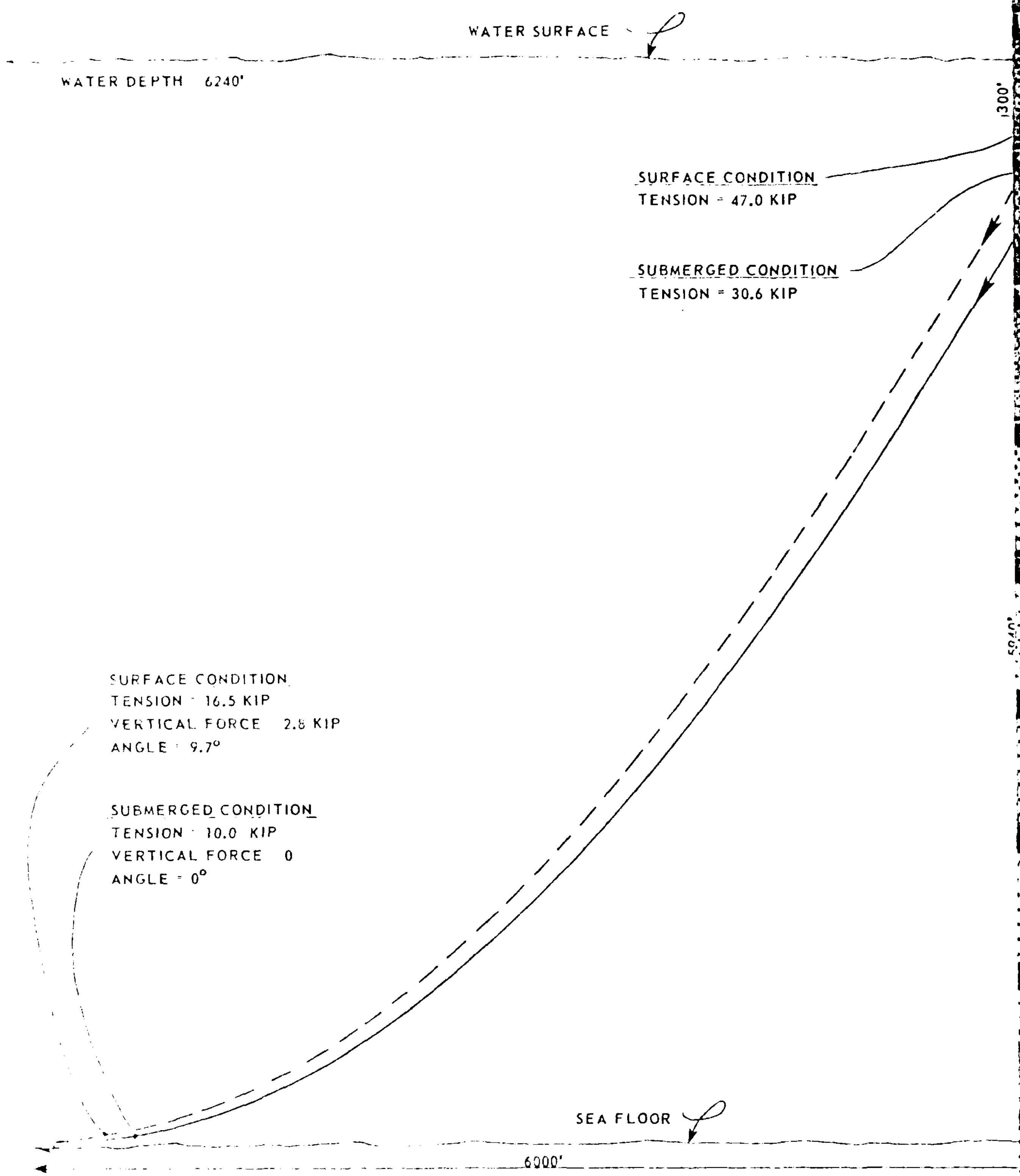
The *SQUAW* mooring system consists of four legs aligned in one plane. Two legs are suspended vertically from the hull, each to its own clump or counterweight. These counterweights resist the major part of the vessel's reserve buoyancy and hold the *SQUAW* at a submerged depth of 300 feet. Two additional mooring legs are included to resist fore and aft excursions. These legs form catenaries and also add to the vertical force opposed by the vessel's reserve buoyancy. The *SQUAW* will be installed in 6240 feet of water. Anchor spread will be on the order of two nautical miles. The moor geometry is shown in Figure 3-1.

The mooring has been designed with a projected life in excess of five years. A substantial effort in the design has been to optimize the installation to preclude overstressing components before the mooring is set. The environmental loadings on the system are highly predictable in that the *SQUAW* is submerged 300 feet. Significant safety factors over the submerged conditions are included. The highest stresses occur during the installation phase, hence the greatest effort has been to optimize this installation.

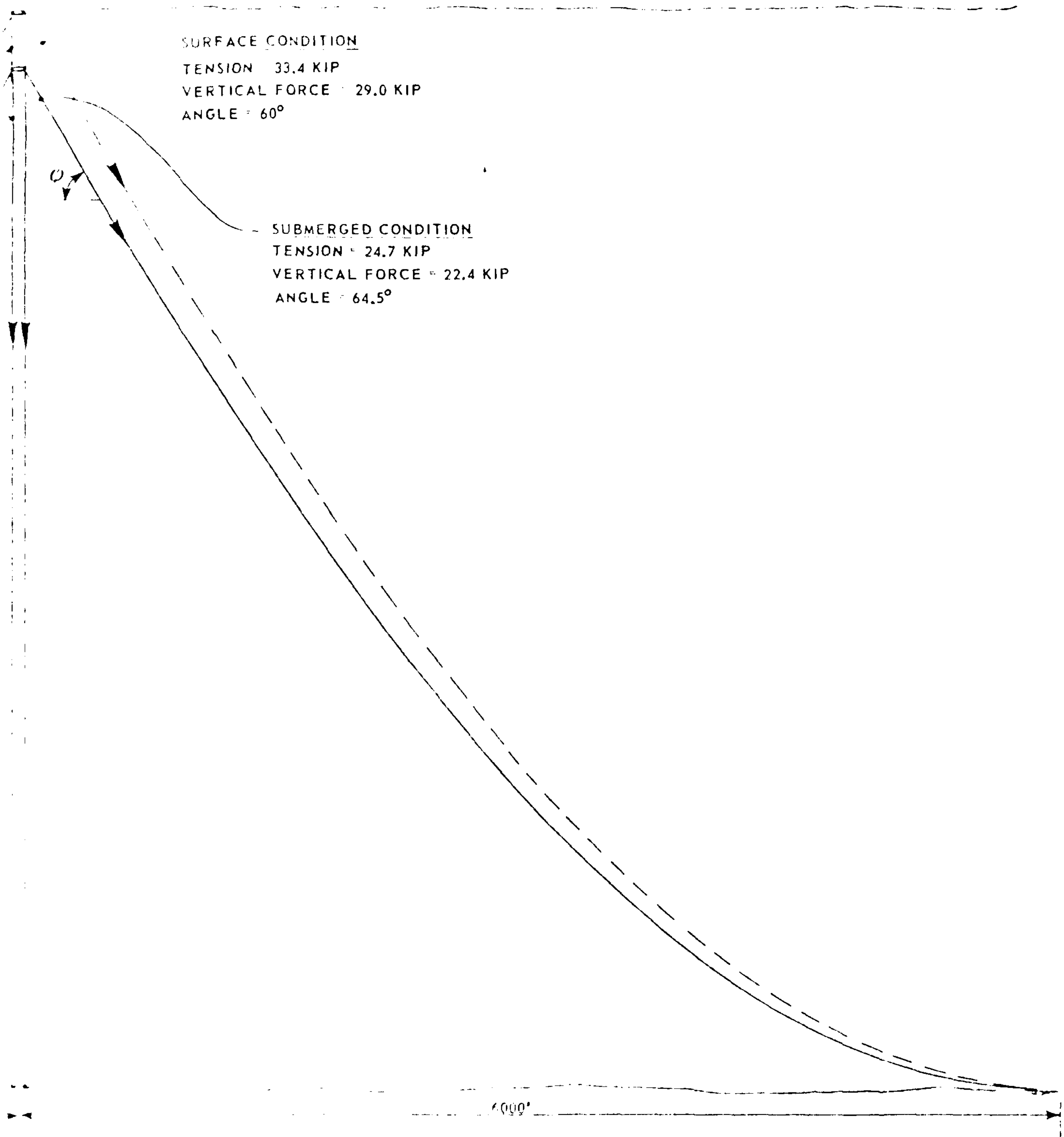
The design philosophy with regard to installation has been to present an approach where the mooring wire rope is installed under only its own weight. All anchors are lowered with crown lines detachable by acoustic release. The various legs are installed separately with no interdependence during installation. The operation can be halted between the installation of each leg due to adverse weather. There is no requirement to work in heavy seas.

The mooring system life is dependent on proper distribution of loads which is a function of moor geometry. The installation includes both underwater navigation and leg tension measurement to insure that the moor is installed as close as practical to the planned geometry.

A comprehensive *sensitivity* study was undertaken to analyze the effects of inaccuracies in moor geometry. These studies were performed with computer assistance. Effects of both anchor position errors and depth errors were analyzed. A final geometry was chosen that allowed attainable tolerances


WATER SURFACE
WATER DEPTH 6240'
1300'
SURFACE CONDITION
TENSION = 47.0 KIP
SUBMERGED CONDITION
TENSION = 30.6 KIP
SURFACE CONDITION
TENSION = 16.5 KIP
VERTICAL FORCE = 2.8 KIP
ANGLE = 9.7°
SUBMERGED CONDITION
TENSION = 10.0 KIP
VERTICAL FORCE = 0
ANGLE = 0°
SEA FLOOR
6000'

1 of 2



SQUAW MOOR GEOMETRY AND LOADINGS

FIGURE 3-1

2012

within the installation measurement techniques. Printouts from the final configuration are included in Appendix E. These printouts contain displacements, angles, tensions, vertical forces, horizontal forces, and safety factors for various points along the mooring lines. These data are presented for both surface and submerged conditions. Additionally, the effects of inaccuracies for anchor position and water depth are presented.

The design considerations and trade-offs made during the analytical efforts on this project will be thoroughly reported in the Project Completion Report.

3.2 SYSTEM COMPONENT DETAILS

The *SQUAW* Mooring System has been designed utilizing optimal components designed for the application. Hardware costs and lead times have been traded-off for the reliability gained from utilizing these special components. Additionally, the system has undergone critical examination in the area of corrosion prevention.

The major component in the mooring is wire rope. A detailed parametric study led to the selection of torque-balanced, corrosion protected wire rope of 1 1/4-inch diameter. This rope was purchased on a competitive IFB procurement in accordance with the requirements given in Appendix F. The wire rope procured is manufactured by United States Steel Corporation, who presented their AMGAL MONITOR AA Tiger Brand Torque Balanced Oceanographic wire rope. This rope is particularly suited to the mooring task and has had a favorable track record in mooring applications. The wire rope was fabricated into five assemblies, two units 8570 feet long for the catenary legs, two units 5740 feet long for the vertical legs and one spare unit 8570 feet long. Rather than applying galvanizing after drawing, the AMGAL process draws the wire galvanized. This process provides cathodic protection without decreasing strength for a given diameter.

Each of the assemblies has been cut to length with an accuracy of ± 5 feet. This accuracy exceeds the standard measurement systems used in manufacturing and required hand measurement.

The wire rope procured is designed and fabricated with non-rotating characteristics. The specification calls for rotation to be less than 2 degrees per foot length when loaded to 50 percent of the rated breaking strength. This rotation is extremely low as compared to other non-rotating wire ropes.

The wire rope is terminated with swaged socket type fittings. These fittings are over sized and specially bored for the 1 1/4-inch wire rope. Each fitting is hot dip galvanized and painted with two coats of black epoxy. A rubber boot is applied to act as a strain relief.

The mooring also utilizes ten shots of 2 inch stud link chain. This chain was in like-new condition. The original design including 1 1/4-inch chain was modified due to availability problems. All chain is cathodically protected with zincs mounted on the hull or clumps and electrically connected to the chain. All chain is connected using two each 2 inch shackles.

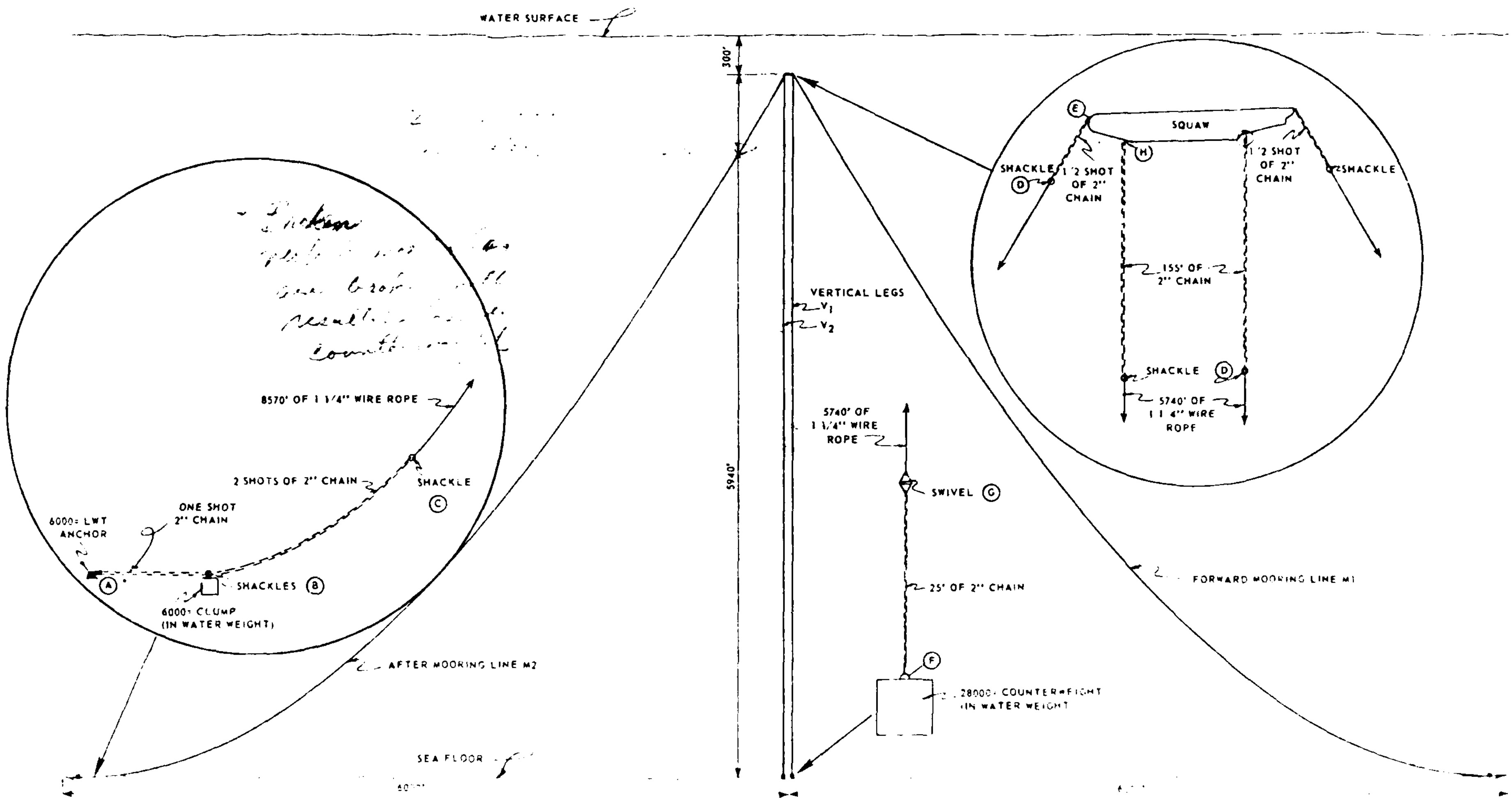
All connections between chain, wire rope and padeyes are made with Crosby Safety Type shackles. These fittings have optimal long term life with regard to corrosion. Two Miller swivels are used in the mooring. These units are rated at 45 tons.

The mooring hardware is shown in Figure 3-2A, 3-2B, and 3-2C. Figure 3-2A shows an overview of the mooring with details given in Figures 3-2B and 3-2C.

3.3 LIST OF EQUIPMENT AND COMPONENTS

The following represents most of the major items supplied for the *SQUAW* moor installation:

ITEM	SOURCE	UTILIZATION
AIR COMPRESSOR (125 CFM)	CROWLEY	MISCL. AIR SUPPLY PLUS DIVER AIR
CARPENTER STOPPERS 1 1/4" (2 EA.)	SUPSALV	INSTALLATION LINE-HOLDING
CARPENTER STOPPERS 1" (2 EA.)	SUPSALV	INSTALLATION LINE-HOLDING
OFFSHORE SUPPLY BOAT (194') (OUTFITTED WITH ALL NECESSARY GEAR)	CROWLEY	SQUAW INSTALLATION
SEAGOING TUG BOAT	CROWLEY	TOWING & SUPPORT
SKAGIT DOUBLE DRUM WINCH	CROWLEY	MAIN LOWERING WINCH
CROWN BUOYS (2 EA.)	CROWLEY	BUOY-OFF MOORING LINES AND/OR LOWERING LINE
WELDING & CUTTING EQUIP.	CROWLEY	MISCELLANEOUS
DIVING GEAR	CROWLEY	DIVER USE
RUBBER TIRE CRANE - 5 TON	CROWLEY	ON-DECK HAULING
HOUSE-TRAILER VAN	CROWLEY	SLEEPING QUARTERS
MISCELLANEOUS RIGGING GEAR SUPPLIES, ETC.	CROWLEY	MISCELLANEOUS



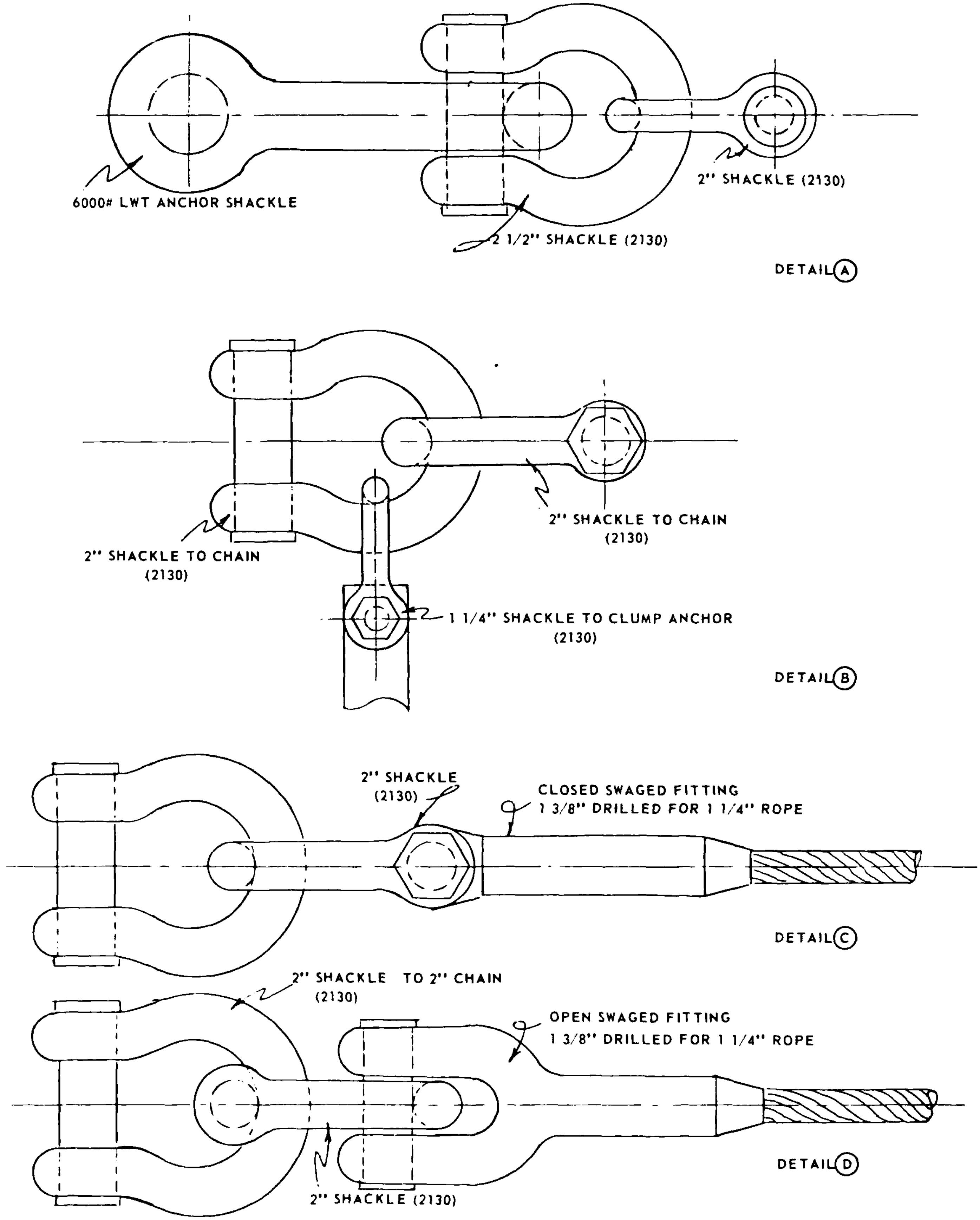
*DETAILS ARE ILLUSTRATED IN FIGURES 3.1B AND 3.1C

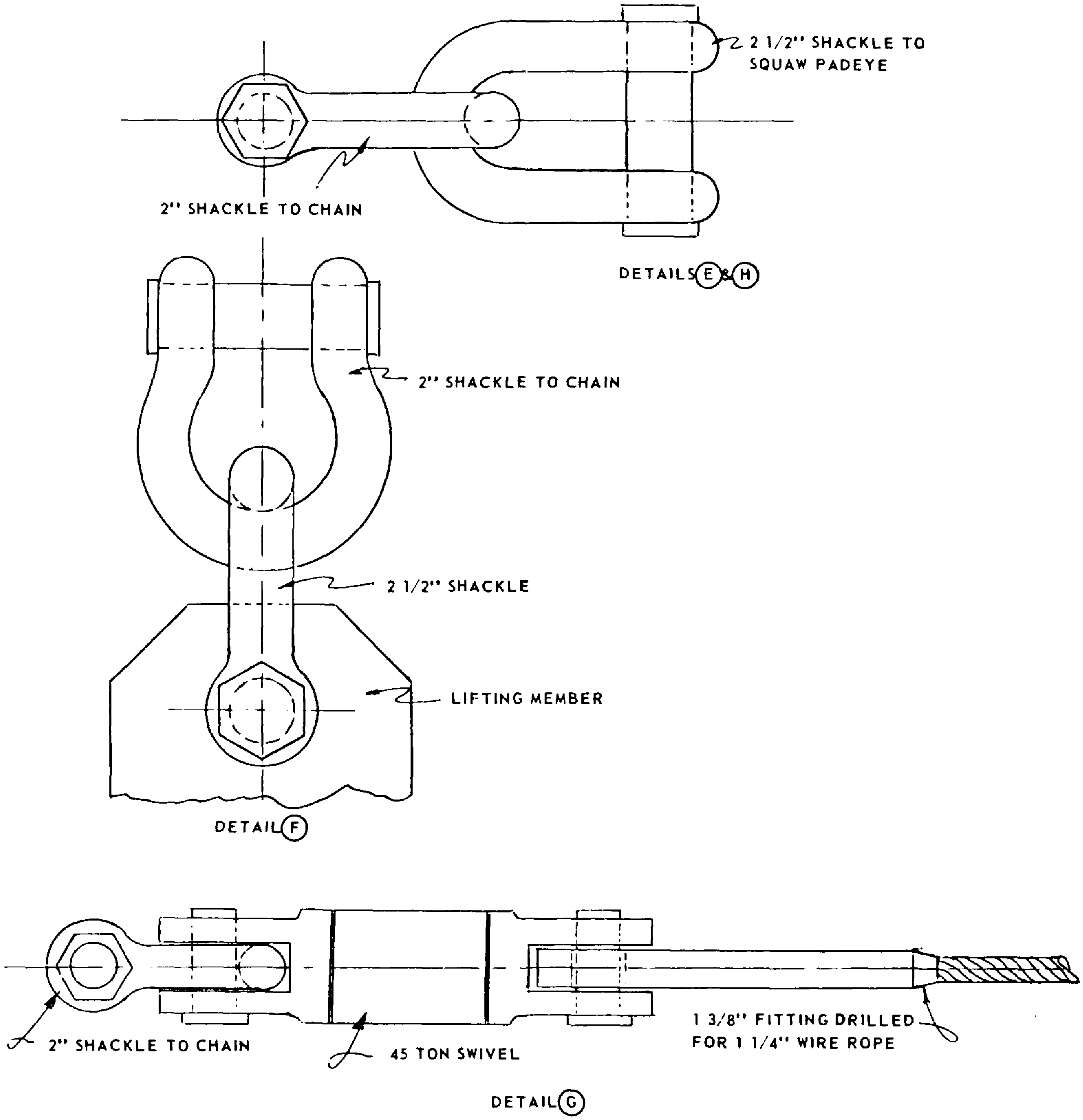
SQUAW MOOR COMPONENTS

FIGURE 3.1A

MOOR COMPONENT DETAILS

FIGURE 3-2B





MOOR COMPONENT DETAILS

FIGURE 3-2C

ITEM	SOURCE	UTILIZATION
CHAIN 2" 6 SHOTS	OCEI*	RIG SQUAW (PENDANTS) MOORING LINES
CHAIN 2 1/4" 6 SHOTS	OCEI	CONCRETE CLUMP FILLERS
CHAIN 2" 14 SHOTS	OCEI	RIG SQUAW MOORING LINES
WIRE ROPE 1 1/4" 5740' REEL (2 EA.)	U. S. STEEL	MOORING - CENTER LEGS
WIRE ROPE 1 1/4" 8570' REEL (3 EA.)	U. S. STEEL	BOW & STERN MOORING LINES PLUS SPARE
WIRE ROPE 1 1/8" 12000'	U. S. STEEL	ANCHOR & CLUMP LOWERING LINE
WIRE ROPE 1" 2900' (4EA.)	OCEI	SPARE CABLE
SWIVELS 45 TON	MILLER (MFR)	MOORING LINKAGE
SHACKLES (VARIOUS) (68 EA.)	SUPSALV STORAGE	MOORING LINKAGE
MISCELLANEOUS TOOLS	OCEI	SQUAW OUTFITTING
TENSIONMETER DILLON 40,000 LB.	OCEI	MOORING TENSION READ-OUT
DYNAMOMETER (NSRDC) 100,000 LB.(2 EA.)	SUPSALV - NSRDC	MOORING TENSION READ-OUT
DYNAMOMETER DILLON 50,000 LB.(2 EA.)	SUPSALV - NSRDC	MOORING TENSION READ-OUT
TURNBUCKLE #G-228-2" (2 EA.)	CROSBY (MFR)	DYNAMOMETER SET-UP HARDWARE
ANCHOR LWT - 6000 LB. (2 EA.)	PWC, S. D.	MOORING ANCHOR
STEEL CLUMP 6000 LB. (2 EA.)	OCEI	CONCRETE CLUMP FILLER
STEEL CLUMP 6000 LB. (3 EA.)	OCEI	MOORING CLUMP PLUS SPARE
CONCRETE CLUMP 42,000 LB. (2 EA.)	PWC, S. D.	MOORING CENTER LINE CLUMPS
ANODES-ZINC 4400 LB. (VARIOUS SIZES)	PROCUREMENT	INSTALLED ON SQUAW & ON MOORING SYSTEM COMPONENTS
ACOUSTIC RELEASE COMPONENTS		(RELEASE LOWERING LINES FROM MOORING LINES, CLUMPS, ETC.)
o TRANSPONDERS AMF #322 (5 EA)	OCEI	"
o AMPLIFIER	OCEI	"
o CODER	OCEI	"
o TRANSDUCER	OCEI	"
o SERVICE KIT	OCEI	"
o SQUIBS (8 EA.)	OCEI	"
o STRONGBACK 40 KIP	OCEI	"
o STRONGBACK 40 KIP	AMF	"
o STRONGBACK 100 KIP (3 EA.)	NDBC	"
o RELEASE ELECTRONICS	INTERSTATE ELECTRONICS CORP.	"
o RELEASE RINGS (6 EA.)	AMF	"
o MASTER RELEASE LINK (8 EA.)	CROSBY (MFR)	"
FLASHING LIGHTS (2 EA.)	OCEI	SQUAW - NIGHT TIME
MARKER BUOY ASSY. (2 EA.)	PWC, S. D.	SQUAW - MOORED DEPTH
ELECTRONIC PINGER PACKAGE	NOSC, S. D.	INSTALLED ON SQUAW AS SONAR PINGER
RADIOS - WALKIE TALKIE (6 EA.)	OCEI	DURING MOORING OPERATIONS
CAMERAS & FILM	CHESNAVFACENGCOM	DOCUMENTATION
MOTOR WHALE BOAT OR ZODIAC	CROWLEY	SQUAW INSTALLATION
RAYTHEON #741 PDR	CROWLEY (TETRA TECH)	DEPTH VERIFICATION
MOTOROLA MINI-RANGER SYSTEM	CROWLEY (NAVIGATIONAL SERVICES INC.)	PRECISION NAVIGATION
NOS CHARTS	CHESNAVFACENGCOM	CHARTS OF AREA

*CHESNAVFACENGCOM - OCEAN CONSTRUCTION EQUIPMENT INVENTORY

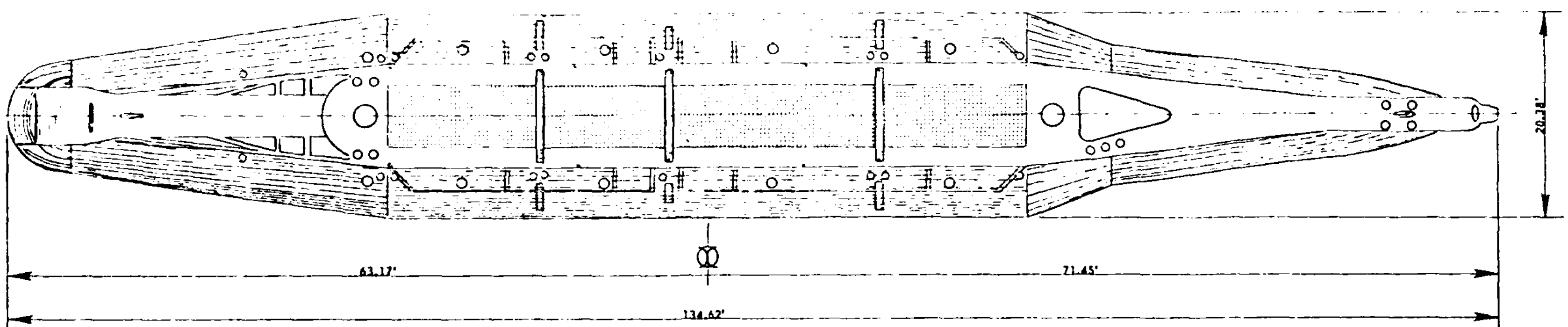
3.4 MAJOR VESSELS INVOLVED IN THE OPERATION

THE SQUAW

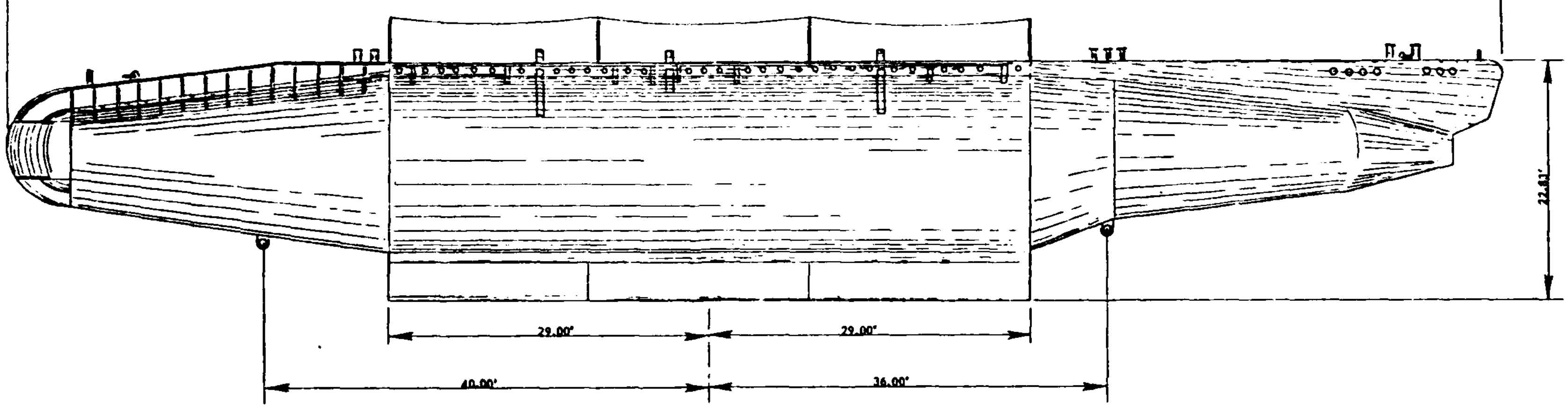
The *SQUAW* submarine, initially designed as a structural model for nuclear tests, has been reconfigured as a sonar target for submarine training, Figure 3-3. The basic pressure hull comprises a 14.5-foot diameter, 58-foot long cylinder to the ends of which are fitted truncated conical sections terminating in hemispherical ends fore and aft; the total length of the pressure hull is 122 feet. The nominal midship section is taken at the midpoint of this length. There are three internal transverse bulkheads fitted at the center and at the ends of the cylindrical portion of the pressure hull. The forward and after trim tanks occupy most of the lower half of the conical end sections with the pressure hull forming the lower and side boundaries of each tank, a deck extending across the pressure hull forming the top boundary, and bulkheads fore and aft of each trim tank forming end boundaries.

External to the pressure hull there are transverse ring frames spaced 2' - 5" along the cylindrical portion and 2' - 0" at the ends. Wrapped around these frames is a cylindrical shell, roughly 20 feet in diameter, which forms a series of ballast tanks external to the pressure hull. Transverse bulkheads, and a longitudinal centerline bulkhead, divide this ballast volume into five pairs of ballast tanks and one pair of free flooding tanks at the after end. The remainder of the superstructure area that surrounds the pressure hull and forms the main deck of the vessel is free flooding. Double, bolted manhole-type hatches fore and aft of the cylindrical portion of the pressure hull provide access from the superstructure deck to the top of each trim tank for filling, pumping out, and checking trim tank water levels. Access from the conical sections of the pressure hull interior to the cylindrical sections is provided through bolted manhole covers in the transverse bulkheads.

For its initial use the *SQUAW* was mass loaded internally. When converted for use as a subsurface sonar target the internal loads were removed and lead ballast was suspended below the keel. This ballast weighs 83.55 tons and extends some 4' - 6" below the keel for the entire length of the cylindrical portion of the pressure hull. This makes the total depth from bottom of ballast to superstructure deck 22.83 feet. Other changes made in the configuration were to extend the bow forward and to erect a protective



SQUAW DECK ARRANGEMENT



SQUAW OUTBOARD PROFILE

FIGURE 3-3

open grill work around the after end of the pressure hull; this extended the overall length to its present 134.62 feet. Padeyes and closed chocks are installed on the superstructure deck for the attachment of fore and aft mooring chains. In addition there are padeyes welded to the keel at points 36 feet forward and 40 feet aft of the midship section; these are for use in connecting vertical legs suspending counterweights for use in a submerged moor.

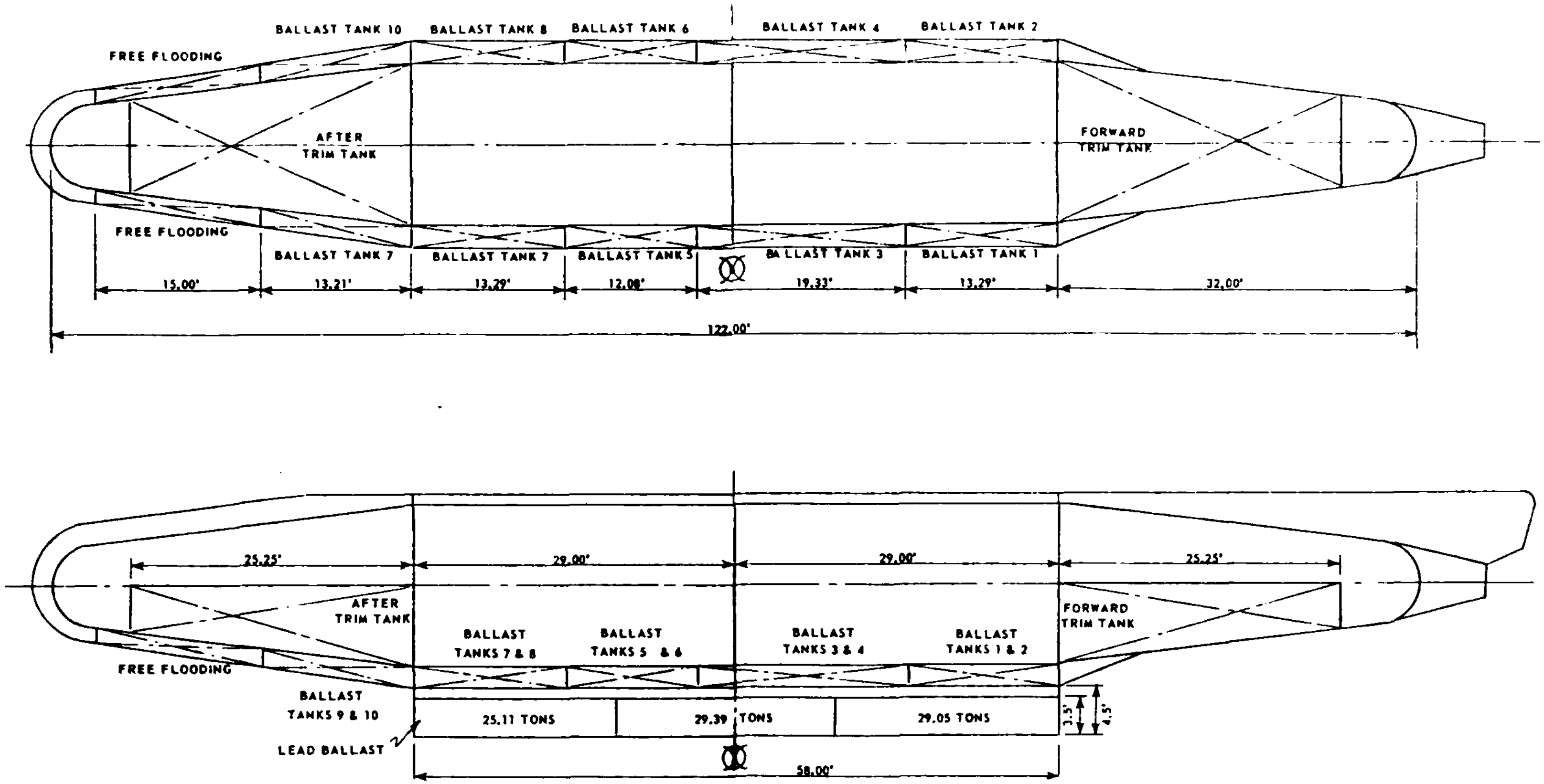
Hydrostatic Curves of Form for the *SQUAW* are given in Figure A-5 of Appendix A. These have been redrawn from data presented in NAVSHIPS 0994-011-2010, "THE *SQUAW*, Technical Report on Submerged Submarine Hull Target". Tank Capacity data obtained from the same source are presented below and can be related to the trim and ballast tanks depicted in Figure 3-4.

The trim tanks each have a total fresh water capacity of 9672 gallons or 35.92 tons. Trim tank capacity curves are available but are not included herein since these tanks are to remain empty for the 1978 operation. For the ballast tanks, the total capacities are given in both tons, fresh water and tons, sea water since both types of ballast are being used:

Ballast Tank	Dimensions in Feet		Total Capacity, L. Tons	
	Length	LCG from ⊗	F. W.	S. W.
1 & 2	13.29	+ 22.35	46.78	48.03
3 & 4	19.33	+ 6.04	68.03	69.85
5 & 6	12.08	- 9.67	42.51	43.65
7 & 8	13.29	- 22.35	46.78	48.03
9 & 10	13.21	- 35.60	35.85	36.81

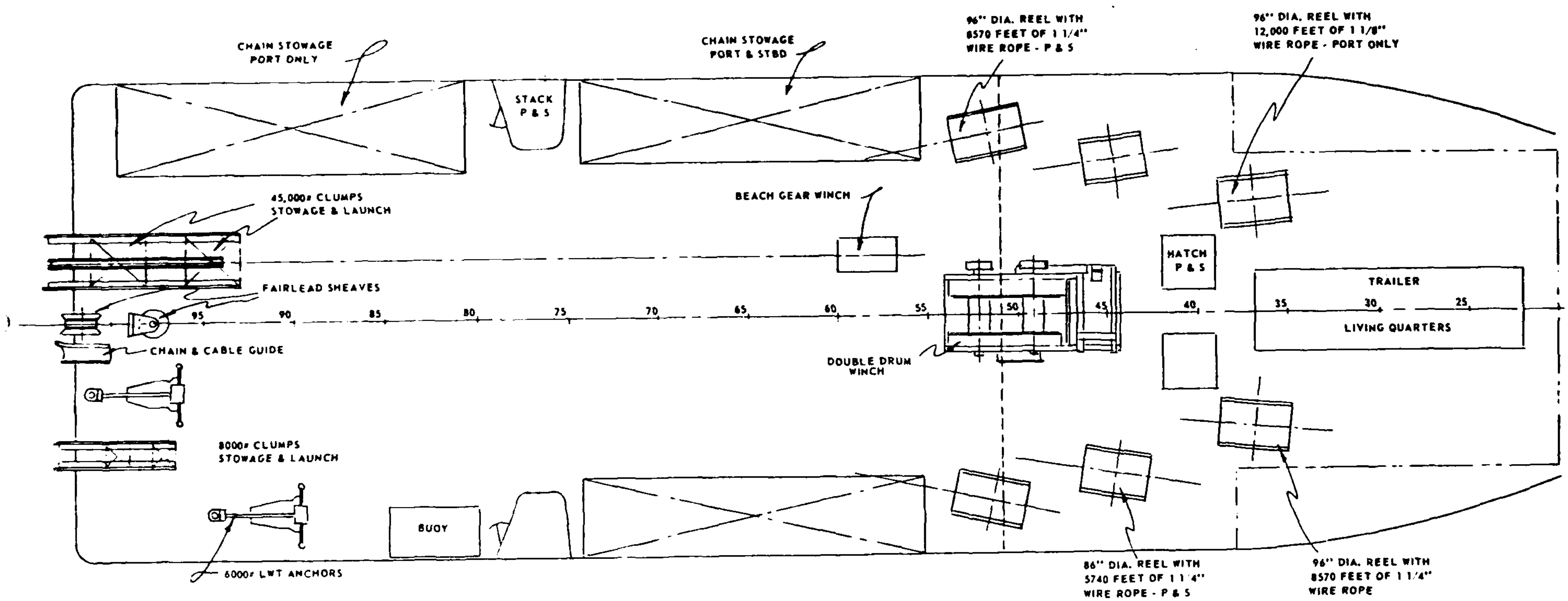
THE M/V MANATI

Principal dimensions and other characteristics of the *M/V MANATI* have been set forth previously in Section 1.5 of this Project Execution Plan. Further details on the after deck arrangement that were planned for the *SQUAW* mooring operation were provided as attachments to the Crowley Operations Plan. The text of this plan is included here as Appendix G. The deck arrangement given is reproduced in Figure 3-5 together with Figure 3-6 which shows one version of how the structure might be arranged for launching the large clumps or counterweights from the fantail of the *MANATI*. It is to be understood that many of these details may be changed to improve the efficiency of the



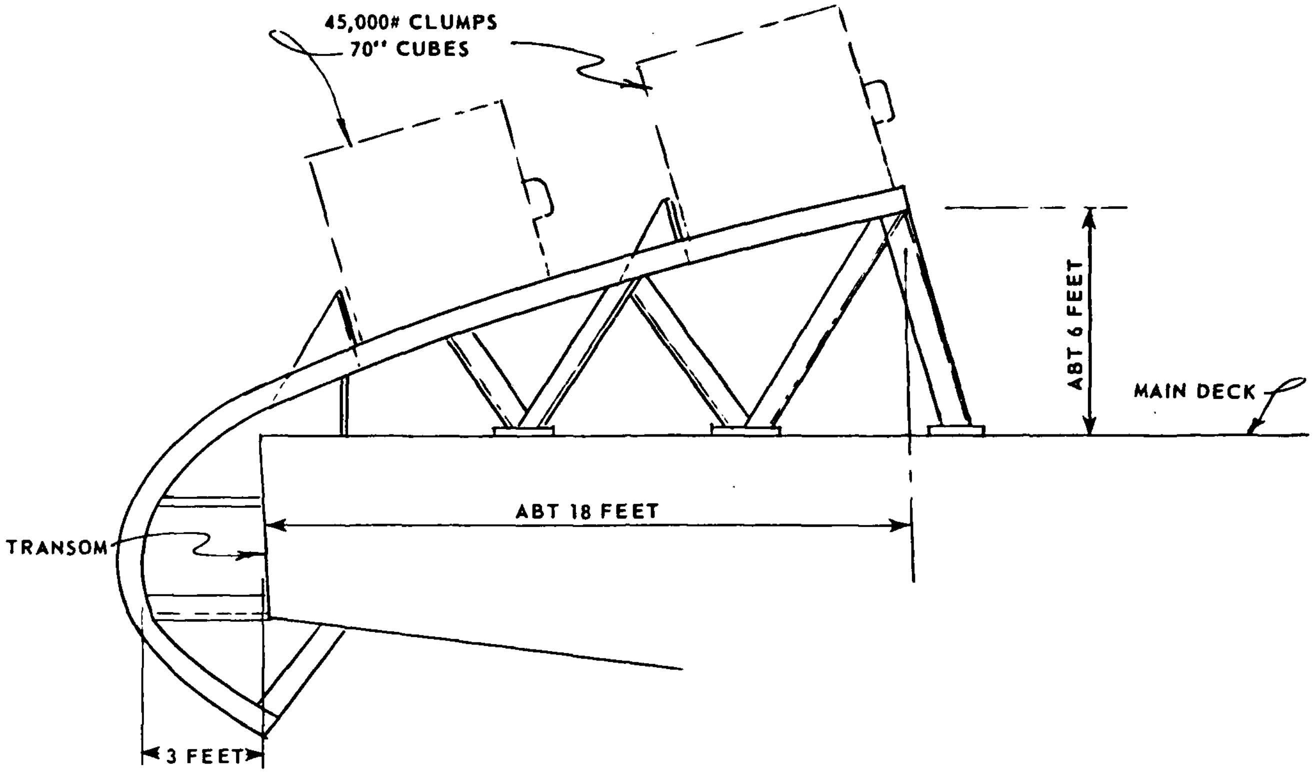
SQUAW TRIM AND BALLAST ARRANGEMENTS

FIGURE 3-4



M/V MANATI
MAIN DECK ARRANGEMENT FOR SQUAW MOOR

FIGURE 3-5



CLUMP LAUNCHING RACK

FIGURE 3-6

operation. Additionally, the five ton rubber-tired crane, to be carried on the main deck aft, is not shown on Figure 3-5.

4.0 INSTALLATION OPERATIONS PLAN

4.1 STAGING FOR THE INSTALLATION

The *SQUAW* will be prepared and outfitted for the installation alongside Pier 13, U. S. Naval Station, San Diego. The *M/V MANATI* will be partially outfitted at the Crowley facility in Oakland, Calif. Upon arrival in San Diego all remaining equipment will be loaded on the *MANATI*. Plans call for the *MANATI* to remain at the installation site until the project is completed without the necessity for returning to port. A Crowley tug from the San Diego or Long Beach area will assist with the operation.

Limited deck space at Crowley's San Diego facility may require either the *MANATI* and the tug, or a Crowley crane barge, or all three, to load equipment at the U. S. Naval Station, Pier 13.

Prior to leaving San Diego, the Mini-Ranger System, the acoustic release equipment, and the precision depth recorder will be installed aboard the *MANATI* and checked out.

4.2 SQUAW FINAL STATUS PIERSIDE SAN DIEGO

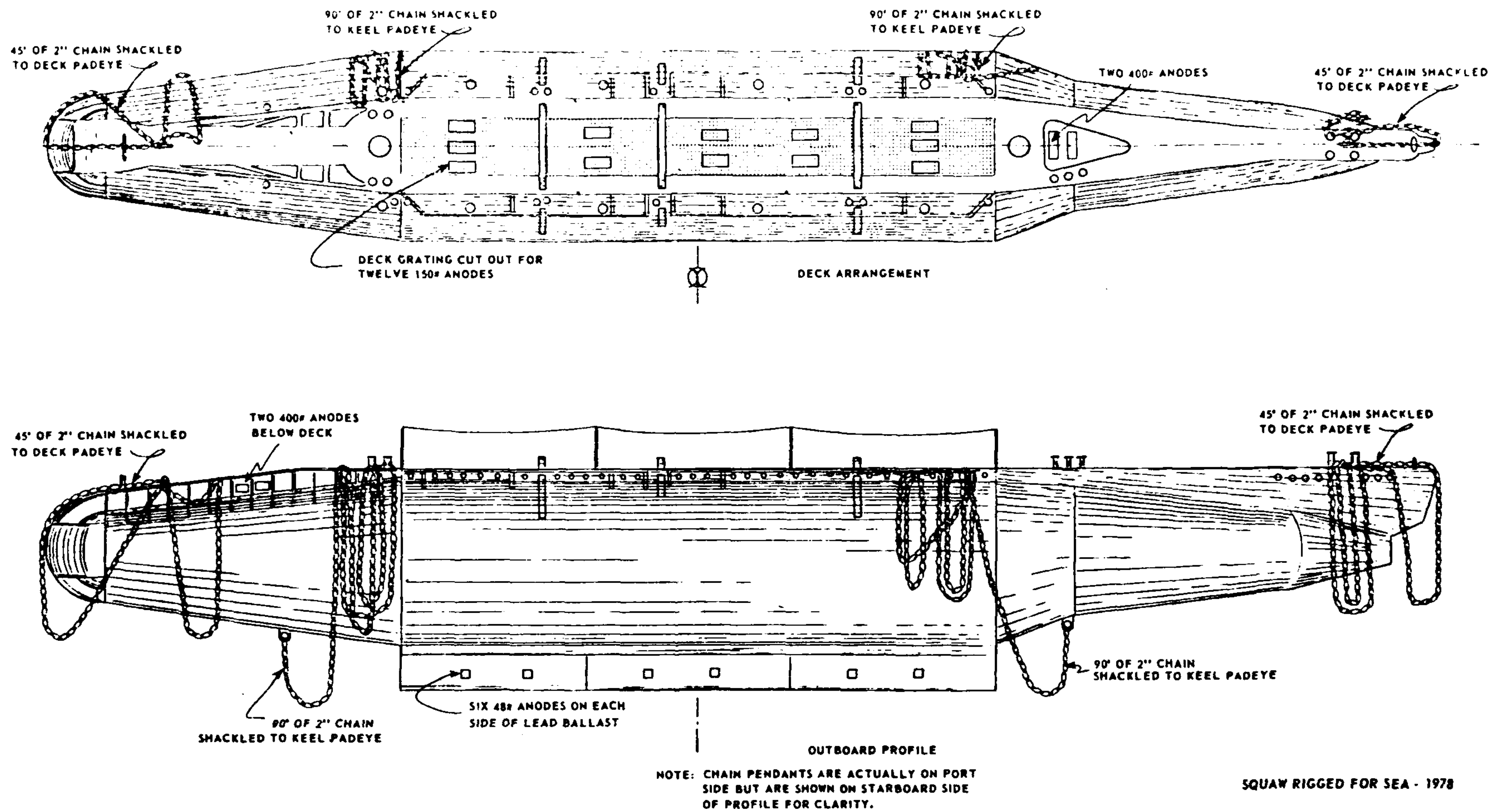
The *SQUAW* will be fully rigged for mooring and ready for delivery to the installation contractor at Pier 13, Naval Station, San Diego. All buoyancy will be adjusted for final installation; chain pendants will be rigged for each of the four mooring attachments. Approximately two tons of zinc anodes will be installed on the vessel for protection of both structure and mooring chain. A lifeline will be rigged down the longitudinal center line of the vessel for safety purposes during at-sea operations. Two flashing white lights will be rigged for use during night operations. These lights are not to be used while the *SQUAW* is being towed. An electronics package will be installed on deck by PWC. This package is to be provided by NOSC. Figure 4-1 shows the *SQUAW* ready for sea.

The *SQUAW* trim and ballast system will be set up as follows:

Forward Trim Tank - Void
After Trim Tank - Void

Ballast Tank	
1	Full (Fresh Water)
2	Full (Fresh Water)
3	Void (Pressurized with Open Bottom)
4	Void (Pressurized with Open Bottom)
5	Free Flooded (Open Bottom & Open On Deck)
6	Free Flooded (Open Bottom & Open On Deck)
7	Void (Pressurized with Open Bottom)
8	Void (Pressurized with Open Bottom)
9	Full (Fresh Water)
10	Full (Fresh Water)

All valves on the ballasting manifold will be closed. All main ballast valves (6 inch) will be closed except for those on tanks 5 and 6. The operation of ballasting valves is described in Section 4.3 of this report.



SQUAW RIGGED FOR SEA - 1978

FIGURE 4-1

The chain pendants for the mooring will be rigged as follows:

Bow & Stern Pendants

Each of these pendants is made up of 45 feet of 2 inch chain. Each is connected to its respective padeye on deck and led through its fairlead. The remaining chain is brought to the port side and suspended in bights from deck structures with manila line. Each bitter end is secured to a deck fitting with wire rope and clips which can be removed at sea.

Vertical Leg Pendants

Each of the two vertical leg pendants is made up of 90 feet of 2 inch chain. Each is connected to its respective padeye under the vessel. Both chains are led to the port side and suspended from framework in bights with manila line. Each bitter end is secured to a deck fitting with wire rope and clips which can be removed at sea.

4.3 OPERATIONS PROCEDURE

The *SQUAW, M/V MANATI* and tug are all rigged as previously described.

STEP 1 - SQUAW BALLAST CHECK

At pierside perform a final ballast check to determine conditions prior to going to sea. Check that ballast tanks 1, 2, 9, and 10 are pressed full by removing inspection plates on top of each tank. Add fresh water if required. Connect air supply hose to main deck manifold and blow tank ballast from tanks 3, 4, 7, and 8. When the tanks are void,air will be observed escaping from beneath each of the tanks. Secure all air manifold valves and remove air supply hose. Remove the cover flanges from the main 6 inch valves on tanks 5 and 6. Open both 6 inch valves to allow free flooding. Ballast tanks 5 and 6 will be permitted to free flood throughout the installation.

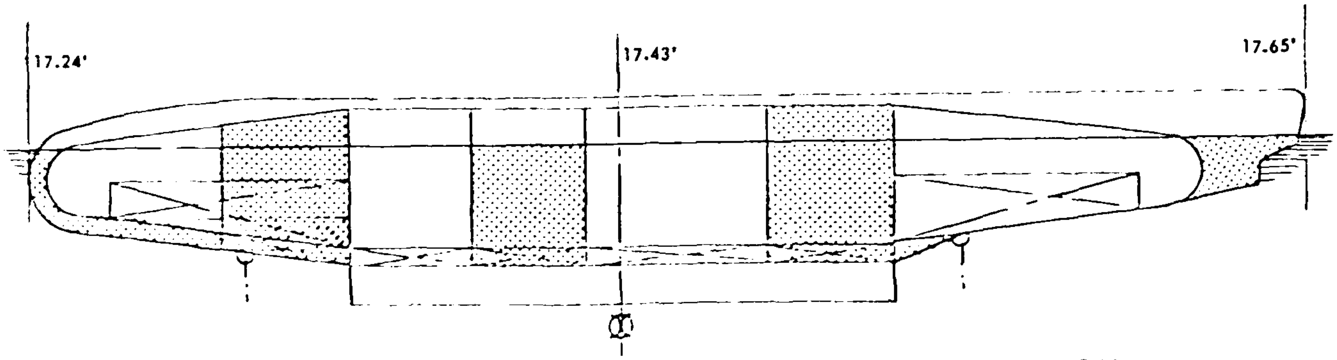
STEP 2 - RIG BOW TENSIONMETER

Aboard the *MANATI*, rig the 50 KIP tensionmeter hardware into the bow chain pendant. The tensionmeter will not be installed at this time, but will be retained aboard the *MANATI*. The hardware to be rigged includes two each 2 inch chain stoppers (releasable), a 2 inch turnbuckle and two 1 1/4 inch screw pin shackles. This hardware is to be installed parallel to the bow chain between the deck padeye and bow mooring fairlead. The tensionmeter will be installed at sea and loaded utilizing the turnbuckle prior to deployment of the bow leg.

STEP 3 - TOW TO SEA

The Crowley tug will accept the *SQUAW* for tow at Pier 13, Naval Station, San Diego. The *SQUAW* will be towed by the bow through her pre-rigged bow chain pendant. This pendant is made up of 45 feet of 2 inch stud link chain connected to a deck padeye through a fairlead on the bow. The tug will attach a towing hawser to the free end of this chain pendant for towing. Portable navigation lights are to be provided by and rigged on the *SQUAW* by the tug crew. The transit speed is to bc a maximum of 5 knots.

The *SQUAW* in the towing condition is trimmed 0.41 feet down by the head as shown in Figure 4-2.



TOWING CONDITION: BALLAST TANKS 1, 2, 9, & 10 FULL; 5 & 6 FREE FLOODING; 3, 4, 7, & 8 BLOWN

FIGURE 4-2

STEP 4 - RENDEZVOUS AT MOORING SITE

Departures of the *M/V MANATI* and the tug with *SQUAW* in tow are to be coordinated for arrival at the *SQUAW* mooring site at approximately the same time and preferably at first light. During transit to the site (117° 50' W. Longitude, 32° 20' N. Latitude), the *MANATI* will perform a fathometer calibration at two locations using charted depths. These two locations will be generally along the line between San Diego harbor and the mooring site.

STEP 5 - DEPTH VERIFICATION

The *MANATI* will maneuver to the final planned position of the *SQUAW* (117° 50' W. Longitude, 32° 20' N. Latitude). The depth will be measured with a precision fathometer. Previous surveys have shown the depth to be 6240 feet at this position, however, a different navigation system was utilized. The final system specifications require a submerged depth of the *SQUAW* to be 300 feet plus or minus 50 feet. All hardware components have been pre-sized for this depth. To remain within tolerance, the water depth must fall between 6190 and 6290 feet. As the final *SQUAW* depth is determined by the vertical leg length, a final adjustment in the chain portion of these legs will be made based on the fathometer readings. If, however, the fathometer indicates the depth is outside of the range of 6190 to 6290 feet, the *MANATI* will maneuver within a circle of 1/2 N. mile radius to locate a position within the depth range. The position with correct depth will become the new final mooring position. Note: If no position within the specified depth range and watch circle is found, the position with depth closest to the design goal will be chosen and vertical leg lengths altered to cause conformance to the depth specifications. *SQUAW* buoyancy changes may be required if significant depth differences are encountered.

STEP 6 - TRANSFER BOW CHAIN PENDANT FROM THE CROWLEY TUG TO THE MANATI

While the *MANATI* maintains position at the final *SQUAW* mooring site, the tug will maneuver alongside the *MANATI*. The end of the 45 foot bow chain pendant will be transferred from the tug to the *MANATI*.

STEP 7 - RIG TENSIONMETER ON SQUAW

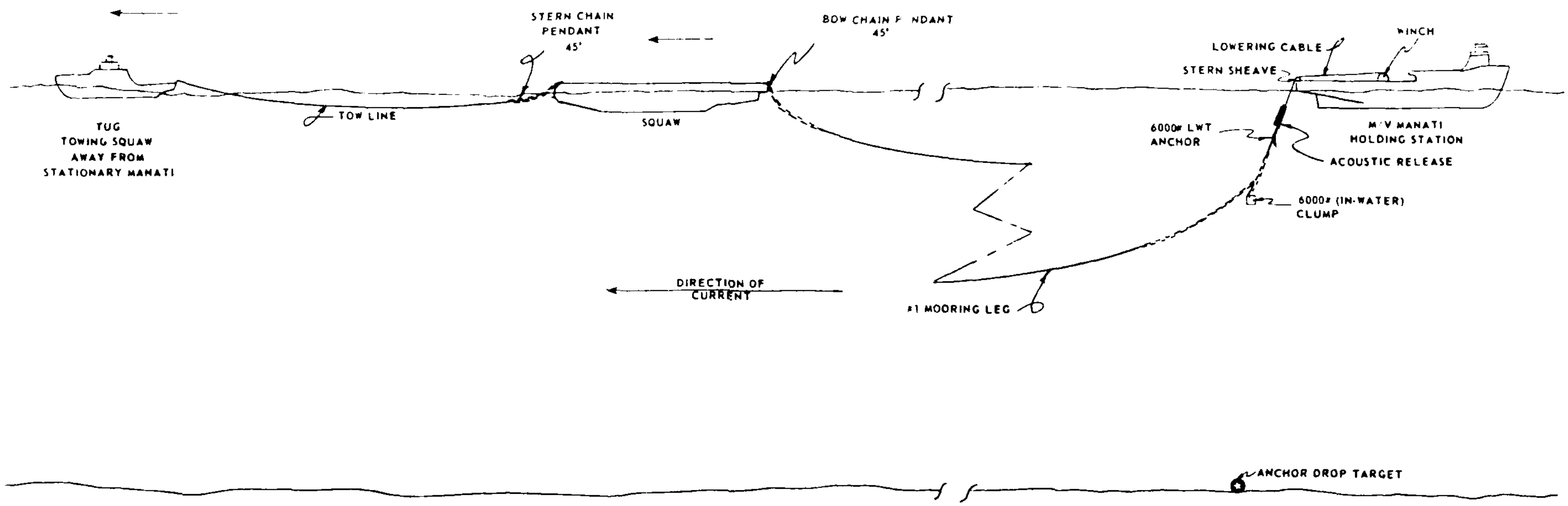
A small boat will be deployed from the *MANATI* to transport a 50 KIP tensionmeter (approximately 35 pounds weight) to the *SQUAW*. The tensionmeter will be inserted into the rigging on the bow chain. The turnbuckle will be used to apply tension to the tensionmeter and slacken the 2 inch chain rigged in parallel. When rigging is complete, the small boat will return to the *MANATI*.

STEP 8 - RECOVERY OF STERN CHAIN PENDANT

While the *MANATI* maintains position over the final mooring site the tug will maneuver to the *SQUAW* stern and recover the stern chain pendant end which has been pre-rigged and lashed to a *SQUAW* deck fitting. The tug will attach a 200 foot towing hawser to the bitter end of this chain. A 40 KIP tensionmeter (GFE) will be installed in the line to measure tension in a later step when setting the bow anchor. The tug will then maneuver to a position so that all three vessels are along a north-south line. The tug will maintain position with her LORAN-C System holding *SQUAW* over the final mooring site as the *MANATI* proceeds with the installation. The position will be plotted by the tug and used in a later step.

STEP 9 - DEPLOYMENT OF BOW MOORING LEG

The *MANATI* will attach the upper end of the bow mooring M1 wire rope to the chain pendant and proceed in a northerly direction while paying-out the wire rope. Figure 4-3 shows this lowering operation. The chain, clump, LWT anchor and acoustic release will be rigged into the mooring string by the *MANATI* and load transferred to the crown wire. The acoustic release will be interrogated when submerged 50 feet and periodically rechecked as it is lowered. The clump, LWT anchor and acoustic release will be lowered until they are placed on the bottom. Utilizing the range and bearing capability



LAYING #1 MOORING LEG

FIGURE 4-3

of the AMF acoustic release system and the Mini-Ranger navigation system, the position of the *SQUAW* bow anchor will be determined. The anchor drop target is located 6000 feet north of the planned final moored *SQUAW* position. The bow anchor will be maneuvered to its final target position by the *MANATI*. In order to accomplish this anchor movement, the tug will reduce thrust to allow the bow mooring catenary to pull the *SQUAW* north of its final position. When the anchor has been positioned properly and checked with both the AMF and Mini-Ranger Systems, the *MANATI* will pay out an additional 1000 feet of crown wire and hold position approximately 500 to 1000 feet north of the bow anchor.

The *SQUAW* draft and trim condition is shown in Figure 4-4 with the bow mooring installed but slack. In this condition the *SQUAW* is trimmed 2.04 feet down by the head.

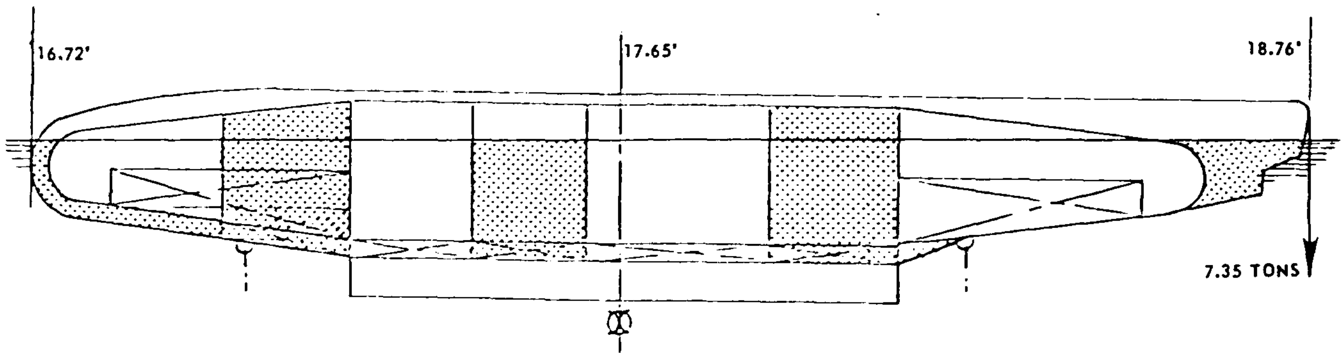
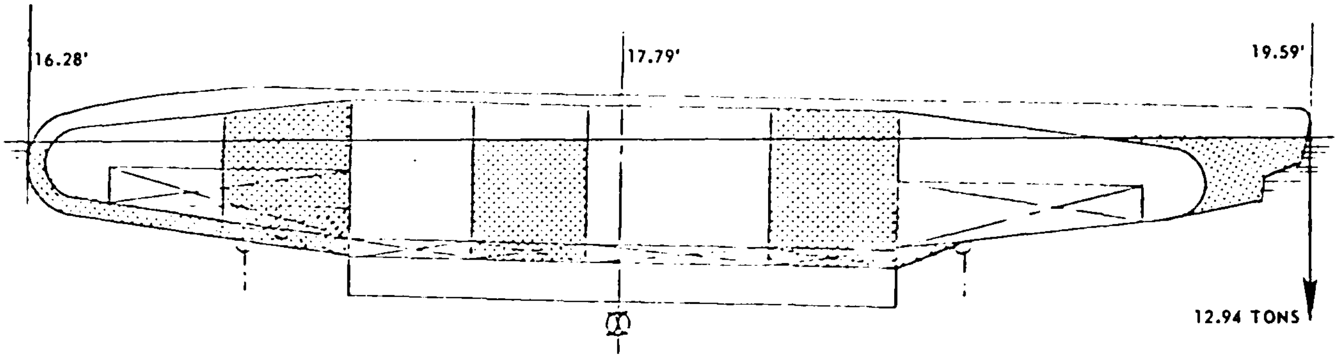


FIGURE 4-4

STEP 10 - SET BOW ANCHOR

The tug will slowly tow the *SQUAW* in a direction due south of the *MANATI* back to the final mooring position as determined by her LORAN C system. The position was previously plotted in Step 8. As the tug pulls the *SQUAW* back to position, tension in the tow line will be monitored. When at the final position, the tensionmeter should read approximately 16000 pounds with the corresponding vertical load on the bow of 12.94 tons. The *SQUAW* draft and trim is shown in Figure 4-5. In this condition the *SQUAW* will be 3.31 feet down by the head.



BOW MOORING OUT & TAUT

FIGURE 4-5

After the final mooring position is reached, an additional pull will be applied to set the bow anchor. The tug will increase thrust until the tensionmeter reads 20,000 pounds. This thrust will be maintained for 10 minutes. The *MANATI*, holding her position, will verify that the *SQUAW* is stationary using radar and the Mini-Ranger System. Some anchor dragging before final set can be anticipated; this may be as much as a few hundred feet. Once the anchor is set, the tug will reduce thrust and allow the catenary to pull the *SQUAW* north past the final mooring position. She will maintain hold of the *SQUAW* and position her approximately 3000 feet north of the final mooring position.

STEP 11 - RECOVER BOW CROWN LINE

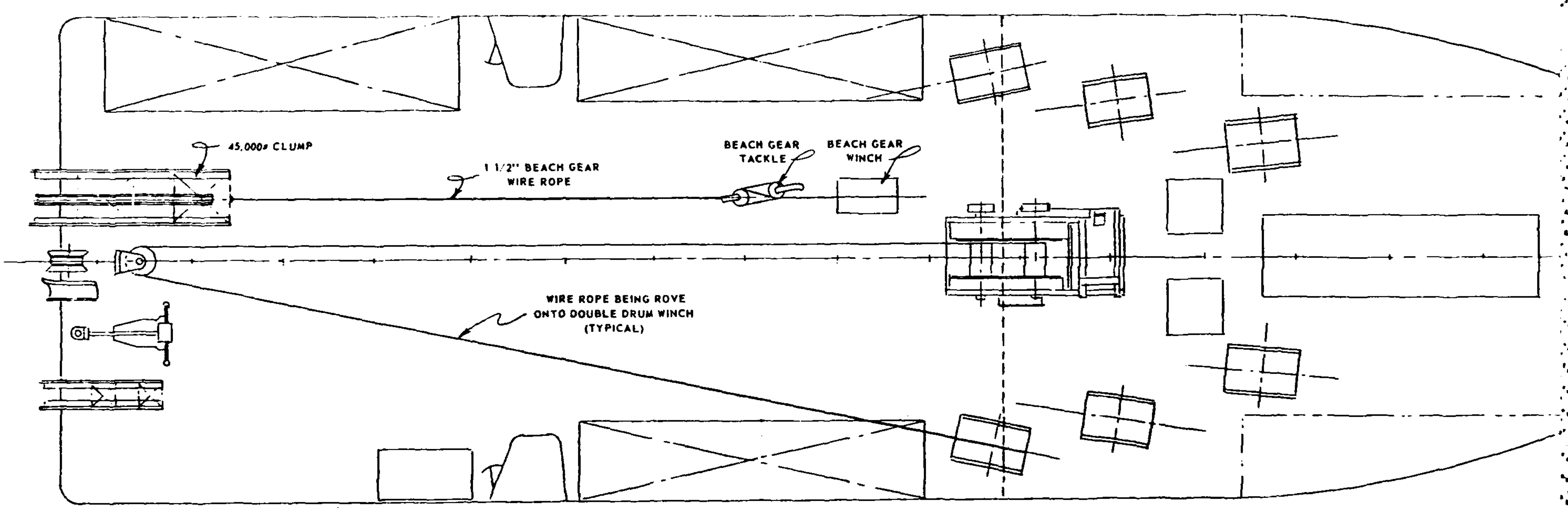
The *MANATI* will activate and release the acoustic release on the bow crown line. After release verification (ping rate change), the crown line will be recovered.

STEP 12 - RELOAD WINCH FOR STERN MOORING LINE

The *MANATI* will reload her winch with the stern mooring line, 8570 feet of 1 1/4-inch wire rope, using the technique illustrated in Figure 4-6. The auxiliary equipment,clump, LWT anchor, chain, and acoustic release, will be repositioned on deck.

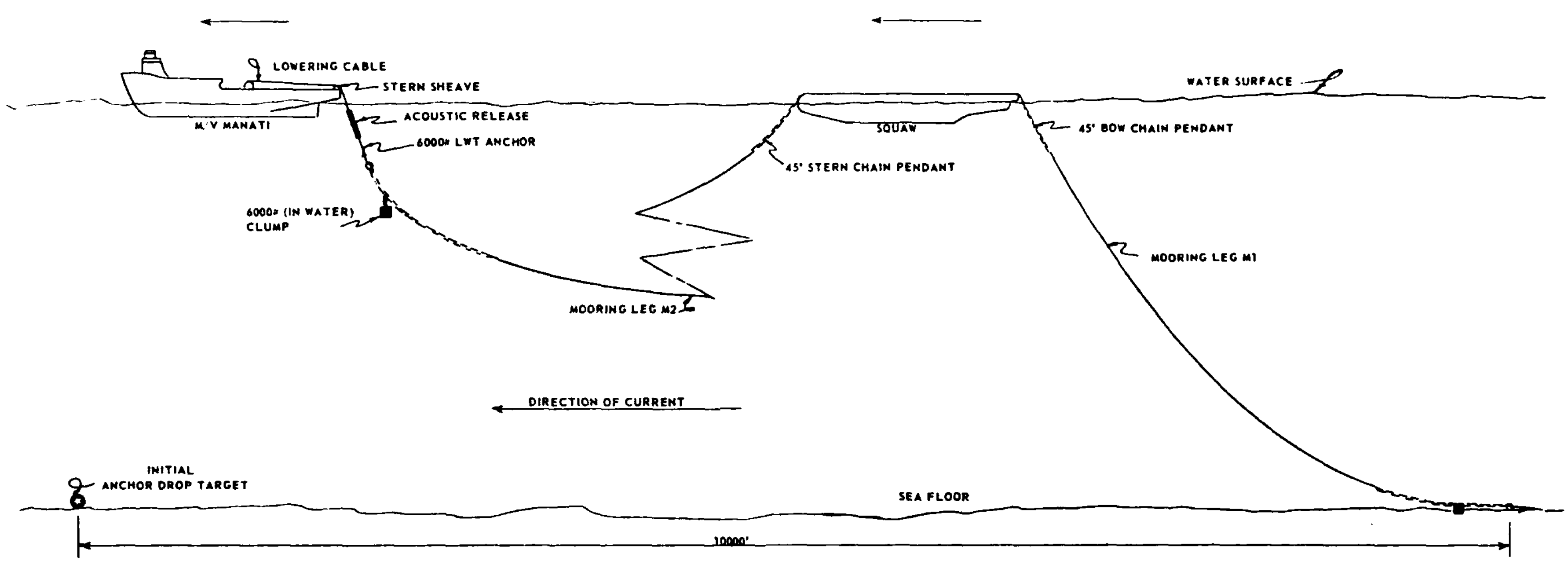
STEP 13 - TRANSFER STERN CHAIN PENDANT TO MANATI

The *MANATI* will maneuver alongside the tug to accept the stern chain pendant. To transfer this pendant, the tug will reduce thrust to allow the bow mooring catenary to relax thereby pulling the *SQUAW* north. Once the transfer is made, the tug will stand by in the vicinity for assistance if required.



MAIN DECK M/V MANATI SHOWING
BEACH GEAR RIGGED TO LOWER CLUMP &
TYPICAL METHOD OF REEVING WIRE
ROPE ONTO THE WINCH

FIGURE 4-6

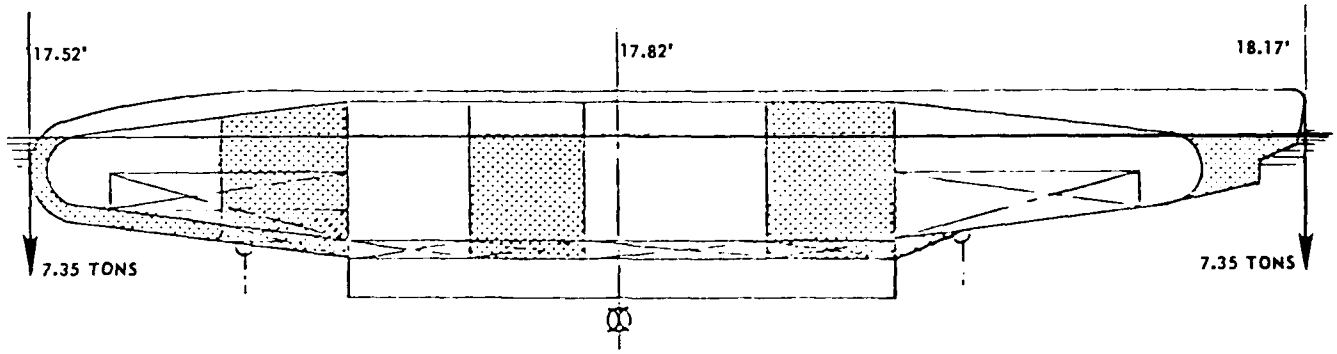


LAYING #2 MOORING LEG

FIGURE 4-7

STEP 14 - DEPLOYMENT OF STERN MOORING LEG

The *MANATI* will deploy the stern mooring leg M2 in much the same sequence as the bow, M1. After the anchor has reached bottom, the *MANATI* will maneuver the anchor to a position 4000 feet due south of the final mooring position. Figure 4-7 shows the stern mooring leg being payed-out. The *MANATI* will pay-out the full 12,000 feet of crown line, attach a buoy to the upper end and deploy the buoy.

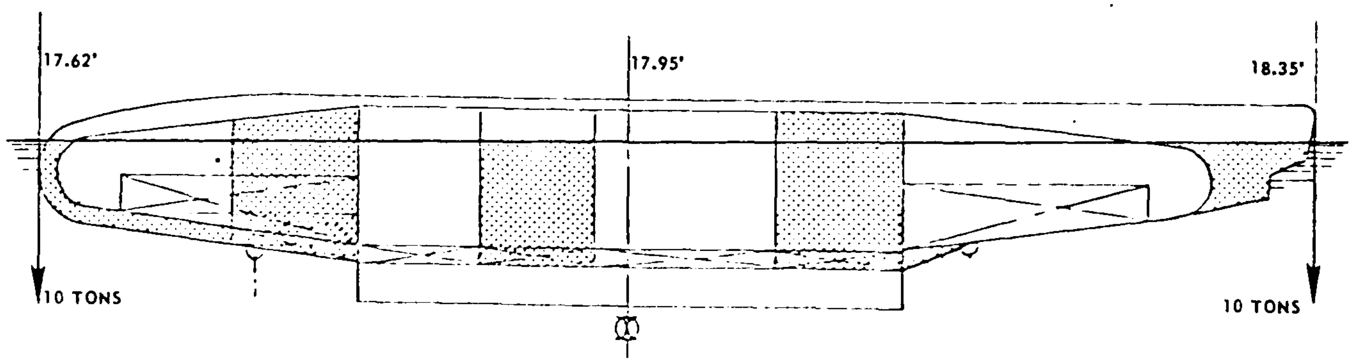


BOW AND STERN MOORINGS OUT & SLACK

FIGURE 4-8

SQUAW trim conditions are shown in Figure 4-8 when bow and stern lines are slack. In this condition, the *SQUAW* is trimmed 0.65 feet down by the head.

As the stern anchor is pulled to its temporary position 4000 feet south of the final *SQUAW* mooring position, the trim conditions are shown in Figure 4-9. In this case, the *SQUAW* is trimmed 0.73 feet down by the head.



BOW AND STERN MOORINGS PARTIALLY TAUT; BALLAST TANKS 1, 2, 9, & 10 FULL; 5 & 6 FREE FLOODING

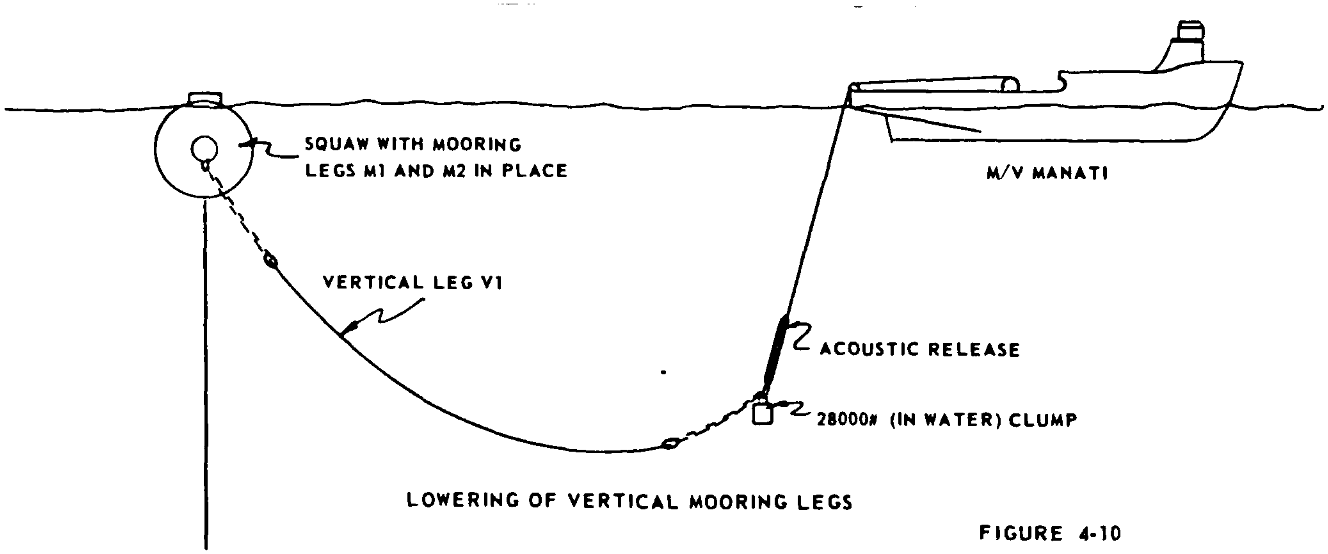
FIGURE 4-9

STEP 15 - RE-RIG MANATI FOR BOW VERTICAL LEG DEPLOYMENT

The *MANATI* will reload the main winch with the 5740 foot wire rope for the bow vertical leg V1. She will also load the second drum of the winch with the final 8570 foot length of 1 1/4-inch wire rope to be used as a crown line *for* lowering both vertical legs. Auxiliary hardware including chain, swivels, acoustic release, clumps, and fittings will be positioned on deck for installation. The exact length of chain required for correct *SQUAW* depth determined from measurements in earlier steps will be cut and faked out for installation. The chain pendant on *SQUAW* attached to the bow vertical leg padeye, V1, is 90 feet.

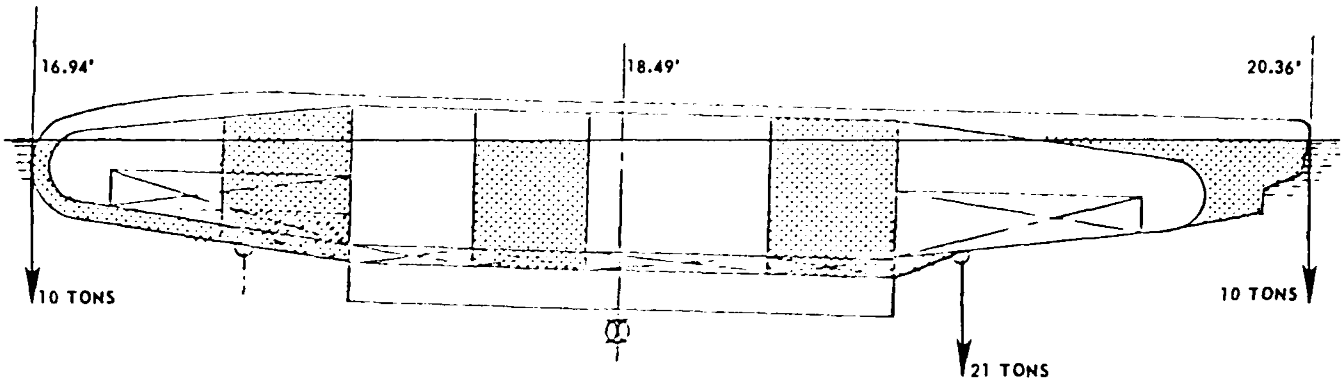
STEP 16 - INSTALL BOW VERTICAL LEG

The *MANATI* will install the bow vertical leg in an anchor-last scenario utilizing a crown wire and acoustic release. She will maneuver to recover the bitter end of the bow vertical leg chain pendant which is secured to a deck fitting. This pendant is 90 feet long. Additional chain will be connected to this pendant determined from previous depth measurements. The vertical leg wire rope will be connected to the chain and deployed as the *MANATI* pulls away from the *SQUAW*. The horizontal separation between *SQUAW* and *MANATI* will be increased as wire is deployed to preclude the possibility of hockling. The Miller swivel will be connected to the lower end of the vertical leg wire and load transferred to the vertical leg clump. The acoustic release will be rigged on a 20 foot wire rope pendant to the clump and connected to the end of the 8570 foot crown line. Once the clump and acoustic release are deployed, the release will be activated to check operation. Periodically, while lowering the clump, the acoustic release will be interrogated to check operation. The clump will be lowered until its weight is transferred to the *SQUAW*. At this point the clump will be directly below the *SQUAW* and 300 feet above the sea floor. A sketch of this operation is shown in Figure 4-10.



LOWERING OF VERTICAL MOORING LEGS

FIGURE 4-10



BOW AND STERN MOORINGS PARTIALLY TAUT; LOWERING FORWARD ANCHOR LEG

FIGURE 4-11

The draft and trim conditions of *SQUAW* with leg V1 are shown in Figure 4-11. In this case the *SQUAW* is trimmed 3.42 feet down by the head.

STEP 17 - RELEASE BOW VERTICAL CLUMP AND RECOVER CROWN LINE

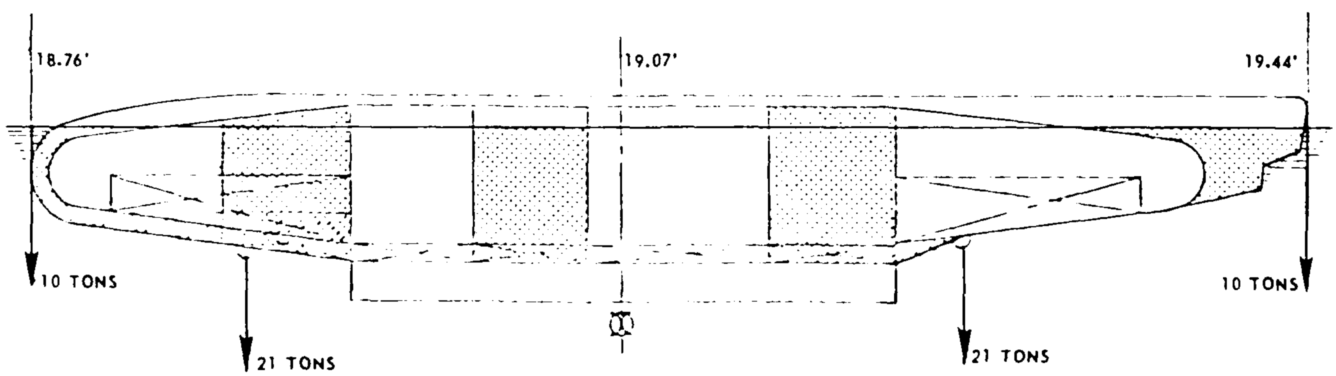
The *MANATI* will activate and release the acoustic release. The operation will be detected by a ping rate change. The crown line will then be recovered.

STEP 18 - RE-RIG MANATI FOR STERN VERTICAL LEG DEPLOYMENT

The *MANATI* will load the final 5740 foot length of 1 1/4-inch wire rope on her main winch. All auxiliary mooring equipment including clump, chain, swivel, fittings and acoustic release will be positioned for installation. The correct length of chain will be cut for attachment to the stern vertical leg chain pendant.

STEP 19 - INSTALL STERN VERTICAL LEG

The *MANATI* will install the stern vertical leg, V2, with the same procedure outlined in Step 16. Draft and trim conditions after this operation are shown in Figure 4-12. In this case, the *SQUAW* is trimmed 0.68 feet down by the head.



BOW AND STERN MOORINGS PARTIALLY TAUT; FORE AND AFT ANCHOR LEGS LOWERED

FIGURE 4-12

STEP 20 - RELEASE STERN VERTICAL CLUMP AND RECOVER CROWN LINE

The *MANATI* will activate and release the acoustic release. Operation will be detected by a ping rate change. The crown line will then be recovered.

STEP 21 - RECOVER STERN MOORING LEG CROWN LINE BUOY

The *MANATI* will recover the stern mooring leg crown line buoy and upper end of crown line. The crown line end will be secured on to the winch and approximately 500 feet wound on to the drum.

STEP 22 - DEPLOY SMALL BOAT

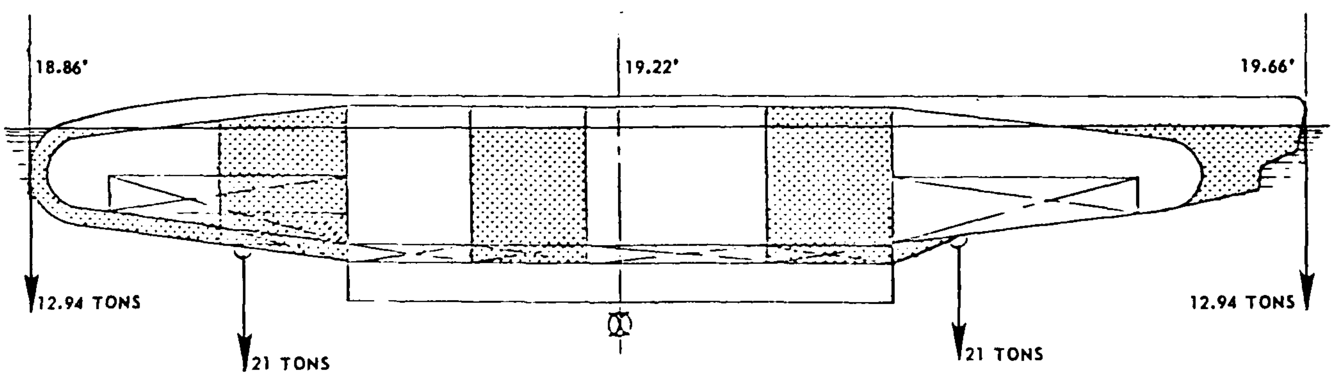
A small boat will be deployed to transfer personnel to the *SQUAW* and to take tension readings on the bow mooring line (tensionmeter previously installed). The tension readings are to be used to insure proper moor geometry and forces. Communication between the *SQUAW* and the *MANATI* will be by hand-held radio. Personnel will remain on *SQUAW* while the stern mooring is positioned.

STEP 23 - MOVE STERN MOORING ANCHOR TO FINAL LOCATION

The *MANATI* will maneuver the stern mooring anchor to its final position. This will be done by dragging the anchor using ship's thrust. Two types of measurements are to be used to accomplish this task. The anchor position can be determined by utilizing the range and bearing capability of the acoustic release system in conjunction with the Mini-Ranger navigation system. The final anchor position is to be approximately 6000 feet south of the final *SQUAW* position. The use of this navigation system to position the anchor is for order of magnitude location only. Inaccuracies in the systems will not insure proper moor geometry. The primary positioning method involves the reading of tension in the bow mooring line. As the *MANATI* tows the anchor toward its target, the mooring line catenary will be stretched and tension will increase. This increase will be detected on the *SQUAW* and radioed to the *MANATI*. The final anchor position will be reached when the tension on the *SQUAW* reaches 33,000 pounds. There is a tolerance on this tension of -2000 pounds and +1000 pounds.

The *MANATI* will utilize the navigation systems to maneuver the anchor on to the north-south line. The tension measurements will be used to locate the anchor along this line. The anchor will be pulled along this line by the *MANATI* thrust. The following example will be used to illustrate the scenario. The *MANATI* will maneuver the anchor on to the north-south line and approximately 1000 feet from the final target position. The *MANATI* will then reduce thrust and tension and will be read on the *SQUAW*. The *MANATI* will then be requested to pull the anchor approximately 200 feet further south and tension will be read again. This sequence will be followed until the tension readings reach 33,000 pounds. A tolerance of -2000 pounds and +1000 pounds is applicable to these readings. With the *MANATI* maintaining position and holding the stern crown line, the tension will be monitored for approximately one hour to determine if the anchor has slipped.

As the stern mooring leg is pulled to the south, and the tension increases in the mooring lines, the downward force on the bow and stern of the *SQUAW* will also increase. When the anchor is finally set the draft and trim condition of the *SQUAW* will be approximately as shown in Figure 4-13. In this case, the *SQUAW* is trimmed 0.80 feet down by the head.



BOW AND STERN MOORINGS TAUT; FORE AND AFT ANCHOR LEGS LOWERED

FIGURE 4-13

STEP 24 - REMOVE TENSIONMETER

The tensionmeter and rigging hardware on the bow mooring line will be removed. A turnbuckle is installed in series with the tensionmeter. This turnbuckle will be opened to transfer the load from the tensionmeter to the parallel chain pendant. All hardware is to be removed and loaded on the small boat.

STEP 25 - REMOVE ALL MISCELLANEOUS RIGGING

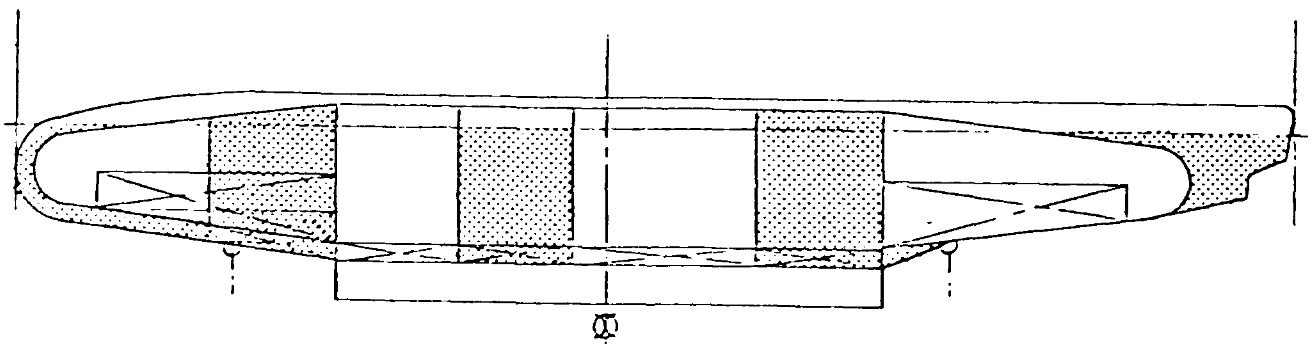
All miscellaneous rigging material is to be removed. This includes the two flashing lights, portable navigation lights, wire straps and tools.

STEP 26 - RIG TEMPORARY DEPTH MEASURING STRINGS

Two depth measuring strings will be rigged on the *SQUAW* connected to the mooring padeyes. These strings will be made up of polypropylene line with small floats applied at 25 foot intervals. As the *SQUAW* submerges to its final equilibrium depth, these strings will indicate this depth. The strings will be connected to the *SQUAW* with breakaway sections at the bottom so that they can be pulled loose from the surface at the completion of work.

STEP 27 - SUBMERGE SQUAW

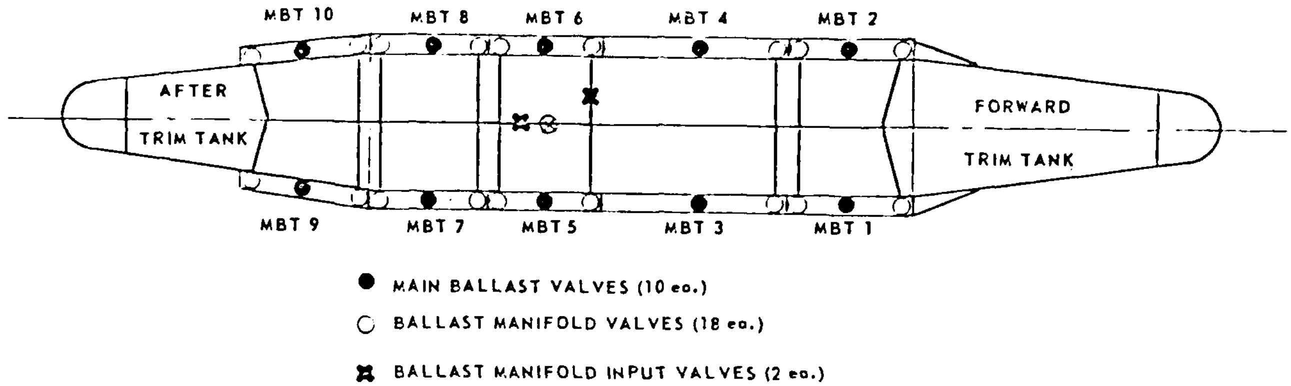
The *SQUAW* will be submerged by flooding ballast tanks. In its present condition, ballast tanks 1, 2, 9, and 10 are filled with fresh water and sealed. Ballast tanks 5 and 6 are free flooded so that water levels inside the tanks equals the outside level. They contribute no buoyancy to the *SQUAW*. The large (6 inch) valves on deck for tanks 5 and 6 are open. The ballast conditions are shown in Figure 4-14.



CROSS SECTION SHOWING BALLAST CONDITIONS

FIGURE 4-14

The deck ballasting manifold is shown in Figure 4-15. Prior to flooding ballast tanks 3, 4, 7, and 8, the valving will be checked. This check will require two men, one to operate the ballast manifold input valves and one to operate the ballast manifold valves for tanks 3, 4, 7, and 8. Both ballast manifold input valves will be initially closed. Sequentially, starting with ballast tank 3, an individual ballast manifold valve will be opened. This will vent air into the manifold. One of the ballast manifold input valves will be momentarily opened to verify tank venting. Both valves will be closed. This procedure will be repeated for all other ballast manifold valves on tanks 3, 4, 7, and 8. This exercise will insure that all valves are operating properly.



DECK BALLASTING MANIFOLD - SQUAW

FIGURE 4-15

The tug will take a position approximately 75 feet off the port side of the *SQUAW*. A radio check will be made to advise all vessels that the *SQUAW* is ready to be submerged. With both ballast manifold input valves closed, all ballast manifold valves for tanks 3, 4, 7, and 8 will be opened. Both ballast manifold input valves will be opened. This will cause ballast to be taken on the *SQUAW*. Finally, four ballast manifold valves on tanks 5 and 6 will be opened. This will prevent air from being trapped if the *SQUAW* submerges with significant trim. All personnel will depart the *SQUAW* and return to the *MANATI*.

STEP 28 - MOORING OBSERVATION

After the *SQUAW* submerges, the depth will be observed by the depth measurement strings utilizing the tug. Both the *MANATI* and tug will stand by for a period of 6 hours observing the *SQUAW* position and depth. The tug will plot and log *SQUAW* position using her LORAN-C system.

STEP 29 - RECOVERY OF STERN CROWN LINE

The *MANATI* will activate and release the acoustic release on the stern crown line. The crown line and release will be recovered by the *MANATI*.

STEP 30 - FINAL POSITION MARKING

The *MANATI* will proceed to the *SQUAW* markers and make depth measurements with her fathometer. The position will be accurately logged and plotted using the Mini-Ranger system. Both depth measuring strings will be recovered. The *MANATI* and tug will then depart for San Diego.

4.4 FORCES ON SQUAW IN SUBMERGED MOOR

As the *SQUAW* sinks from the surface down to its final moored position, at approximately a 300 foot depth, the remaining ballast tanks 3, 4, 5, 6, 7, and 8 plus all open superstructure areas will flood with sea water. As the vessel descends, the total vertical force applied by the bow and stern mooring lines decreases as mooring chain is deposited on the bottom; total downward force from these lines drops from 25.87 tons at the surface to 20.04 tons at 300 feet. When the clumps at the bottoms of the fore and aft vertical legs settle on the bottom, the downward force acting on the *SQUAW* will decrease by another 25.00 tons, the weight in water of the clumps. The final set of forces applied to the *SQUAW* in the moored position are as follows:

Light Ship Weight	409.10 tons
Fresh Water Ballast	82.63 tons
Sea Water Ballast	161.53 tons
Anodes and Instrumentation	2.41 tons
Bow and Stern Mooring Lines	20.04 tons
Fore and Aft Vertical Legs	17.00 tons
Total downward force	692.71 tons
Total submerged buoyancy	700.66 tons
Reserve Buoyancy	7.95 tons

4.5 DEMOBILIZATION

All demobilization will be accomplished in San Diego. If possible (based on time of day, and day of week) the *MANATI* will off-load all Government Furnished Equipment at the U. S. Naval Station, San Diego. PWC will be requested to arrange for personnel and crane support. The Crowley crane barge (if available) and the 5 ton crane aboard the *MANATI* may also be utilized.

A CHESNAVFACENGCOM representative will remain in San Diego to assist PWC with the requirements necessary to ship out all remaining project gear.

APPENDIX A

SQUAW TRIM AND BUOYANCY TEST PLAN AND TEST ANALYSIS

SQUAW TRIM AND BUOYANCY TEST PLAN

PREPARED BY
CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON, D. C. 20374
22 DECEMBER 1977

Note: For the purposes of this presentation the Table of Contents and the Appendices of the initial plan have been omitted.

1.0 INTRODUCTION

To allow the detailed design completion of the mooring system for the *SQUAW*, a buoyancy and trim test is to be performed. This test will include alternately flooding and purging each of the main ballast tanks, while measuring freeboard and trim at each condition. The two trim tanks will be loaded at various stages of the test with fresh water for simulation of the mooring loads.

In addition to the exercise of all tanks to test their function, all buoyancy conditions to be encountered in the final mooring operation will be simulated. These conditions include:

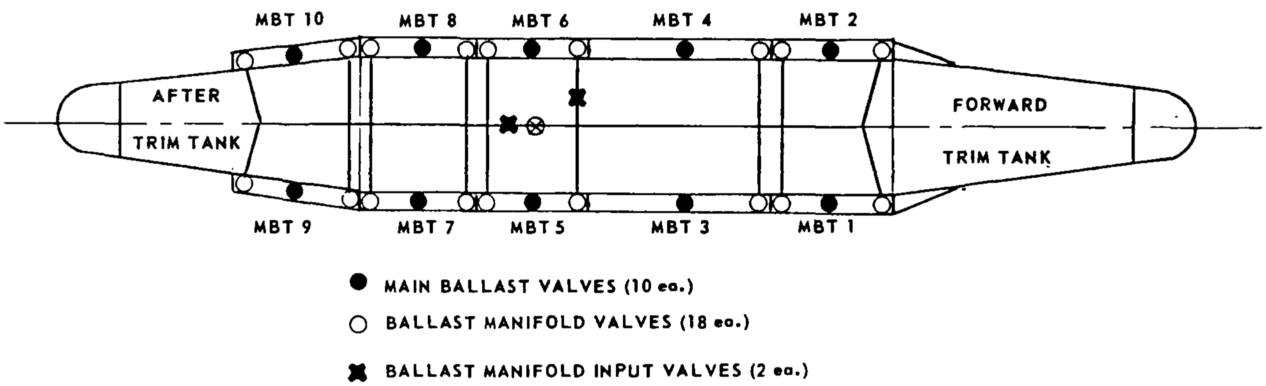
A) Standby at pier
B) Towing condition
C) Surface moored by bow
D) Surface moored by bow and stern
E) Surface moored with bow vertical leg
F) Surface moored with bow and stern vertical legs
G) Submerged in final moor

2.0 BALLAST TANK TRIALS

The initial testing includes trials involving the flooding and purging of ballast from the ten main ballast tanks. These tanks are plumbed together by a common manifold running beneath the deck grating. Two valves are accessible on deck for supply and exhaust of air from these tanks. Figure A-1 shows the numbering scheme for the ballast tanks. The bow starboard tank is

Number 1 increasing aft with odd numbers to Number 9 at the stern starboard side. The port bow tank is Number 2 increasing aft with even numbers to Number 10 on the stern port side.

Step 1: Remove man-way covers to provide access to bow and stern trim tanks. Flanged-dished hatch covers are located on deck near the bow and stern. These covers are each secured with 32 stainless steel hex head bolts (1 inch). A pneumatic wrench is required for removal of the bolts. A second dished cover is fitted beneath each deck cover inside a trunk. Remove the inner covers held in place with the same size bolts.



DECK BALLASTING MANIFOLD - SQUAW

FIGURE A-1

Step 2: Fitthe 1 1/2-inch by 200-foot air supply hose to the ballast tank supply manifold valve penetrating the deck grating above tank Number 6. This hose mates with a 1 1/2-inch male National Standard Hose Coupling Thread (11 1/2 threads per inch). Connect this hose to the pier air supply manifold.

Step 3: Fit the 1 1/2-inch by 100-foot air supply hose to the ballast tank supply manifold valve penetrating the deck grating above tank Number 5. This hose mates with a 1 1/2-inch male National Standard Hose Coupling Thread (11 1/2 threads per inch). The valved end of the hose should be secured to a convenient fitting on the pier.

Step 4: Remove all miscellaneous hardware (chain, shackles, pendants, etc.) from deck and store on pier.

Step 5: Measure and log depth of water in forward and aft trim tanks. Access for depth measurement in each tank is through a 1 1/2-inch bulkhead penetrator welded through the tank top. These penetrators are located on the after top of the forward trim tank and on the forward top of the after trim tank. Each penetrator is closed off with a 1 1/2-inch screwed cap. Water level within the tank can be measured with the dip stick and water finding paste.

Step 6: Empty the forward trim tank using a pier mounted pump. Access to the tank can be obtained by removing the 2 1/2-inch flanged valve on the tank top. The pump suction hose can be lowered through this valve flange.

Step 7: Adjust the water level in the after trim tank so that the tank contains 5.13 tons. Access to the tank is similar to that described in Step 6. Water volume is equal to 1380 gallons and the water depth is 3 ft-1 inch as measured through the sounding tube (1 1/2" tank penetrator - see Step 5).

Step 8: Set up the Dumpy level on the pier with a view of the *SQUAW's* bow and stern deck areas. Establish the elevation of the level sight above the pier and measure the distance from this reference to the water surface. This distance, water surface to level height, must be measured and logged each time a trim reading on the *SQUAW* is taken so that tide changes can be factored out of the calculated draft changes. Mark all positions for measurement for repeatability.

Step 9: Slowly blow all ballast from the ten ballast tanks. Use the main deck manifold. Blow the tanks in the following sequence; 1 & 2, 9 & 10, 3 & 4, 7 & 8, and 5 & 6. Insure that each tank is void by observing air escaping from under the tanks.

Step 10: Take trim measurement with Dumpy level and leveling rod. Log data on sheets included in Appendix A.

Step 11: Open flood valves for tanks 9 & 10. Allow tanks to fill until no air flow is detected out of the vent hose. Take trim measurements and log data.

Step 12: Open flood valves for tanks 1 & 2. When flow has stopped take trim measurements and log data.

Step 13: Open flood valves for tanks 5 & 6. When flow has stopped take trim measurements and log data.

Step 14: Open flood valves for tanks 3 & 4. When flow has stopped take trim measurements and log data. (PRESENT CONDITION SIMULATES TOWING CONFIGURATION).

Step 15: Secure all ballast valves. Slowly open valves for tanks 7 & 8 and check for air flow out of tank. Blow tanks 7 & 8 until air escapes from under the tanks.

3.0 TRIM TANK TRIALS

The following trials include weight adjustments to the hull by adding or removing water from the two trim tanks.

3.1 SIMULATION OF BOW MOORING

A simulation of the buoyancy conditions when the *SQUAW* is moored by the bow on the surface is to be run. The mooring forces for a bow mooring yield a vertical force applied to the bow of 26,100 pounds. This force is to be simulated by loading the forward trim tank with 11.66 tons of fresh water.

Step 16: Run the 1 1/2-inch fresh water supply hose through the deck hatch (forward) and load 11.66 long tons of water into the trim tank. This weight is equivalent to 3130 gallons and a water height inside the tank of 3' - 5" as measured with a dip stick through the sounding tube.

Step 17: Take trim measurements with the Dumpy level and log results.

3.2 SIMULATION OF BOW AND STERN MOORING

A simulation of the buoyancy conditions when the *SQUAW* is moored with both bow and stern lines is to be run. The mooring forces for the stern anchor system are equal to those for the bow system. That is, 26,000 pounds of vertical force will be applied to the stern by the mooring line. This force is to be simulated by loading the stern trim tank with 11.66 tons of fresh water.

Step 18: Run the 1 1/2-inch fresh water supply hose through the deck hatch (aft) and load 11.66 long tons of water into the trim tank. This weight is equivalent to 3130 gallons. The aft trim tank was initially loaded with 1380 gallons so that after this addition the new total will be 4510 gallons or 16.82 long tons. This quantity will fill the tank to a level of 4' - 4 1/2" as measured with a dip stick through the sounding tube.

Step 19: Take trim measurements with the Dumpy level and log results.

3.3 SIMULATION OF FINAL SUBMERGED CONDITION

A simulation of the buoyancy conditions when the *SQUAW* is submerged is to be run. In this condition the two vertical leg anchors will be resting on the sea floor. The *SQUAW* will be supporting the weights of the vertical legs (wire and chain) and the vertical forces applied by the bow and stern mooring lines. Each vertical leg will weigh 15,330 pounds (excluding anchor). Each mooring leg will apply a vertical force of 21,360 pounds. Cumulatively, the vertical forces equal 73,380 pounds. This weight will be simulated by adding water to the two trim tanks so that each represents half of the force.

Step 20: Add water to the stern trim tank, as before, until a total weight of 21.51 long tons is reached. This weight is equivalent to 5780 gallons of fresh water and will bring the water level in the tank to 4' - 11" as measured through the sounding tube.

Step 21: Add water to the forward trim tank, as before, until a total weight of 16.38 long tons is reached. This weight is equivalent to 4400 gallons of fresh water and will bring the water level in the tank to 4' - 0" as measured through the sounding tube.

Step 22: Insure that all deck ballast control valves are closed except for those penetrating tanks 7 & 8. Insure that the 1 1/2-inch supply hose to the deck valve for inlet to the ballast control manifold is connected to the pier air supply with the air supply valve off. Insure that the 1 1/2-inch hose connected to the second deck ballast manifold valve is rigged with the pier-side valve closed. Insure that the two deck ballast manifold valves are open. This will allow control of ballast in tanks 7 & 8 from the pier.

Step 23: Install the gaskets and inner hatch covers above both fore and aft trim tanks using the pneumatic wrench. Install all bolts on the inner hatches.

Step 24: Install the gaskets and outer hatch covers from both fore and aft trim tanks. Four bolts on each cover are required equally spaced around the bolt circle.

Step 25: Open the pier-side valve on the 1 1/2-inch hose to allow tanks 7 & 8 to flood. With these tanks flooded, the *SQUAW* has a calculated reserve buoyancy of 6.70 tons or 15,000 pounds.

Step 26: Rig the 10-ton weight with tensiometer in line for lift from the pier to the *SQUAW* deck. The weight is to be slowly lowered to the centerline, fore and aft, and amidship. As the weight is transferred from the crane to the *SQUAW*, the value registered on the tensiometer will decrease until the *SQUAW's* deck is awash. The tensiometer reading, stabilized with the *SQUAW* deck awash, subtracted from the reading with the weight in air is equal to the *SQUAW* reserve buoyancy. Log the readings on the data sheets provided in Appendix A.

Step 27: Remove the weight from the *SEACON's* deck and secure on the pier. Take trim measurements with the Dumpy level and log results.

Step 28: Blow ballast from tanks 7 & 8 by opening the pier air supply already connected to the ballast manifold.

3.4 SIMULATION OF SURFACE MOORING WITH BOW & STERN VERTICAL LEGS

The simulation of buoyancy conditions when the *SQUAW* is moored with fore and aft mooring legs and the bow vertical leg installed is to be run. The vertical forces to simulate the condition sum up to 138,900 pounds. This load is symmetrically supported by the *SQUAW* and is equivalent to 62.00 long tons or 16,650 gallons of fresh water.

Step 29: Verify that the ballast tanks 7 & 8 are void of water by observing air, when supplied, escaping from beneath the tanks.

Step 30: Remove both outer and both inner hatch covers as described earlier.

Step 31: Add water to the stern trim tank, as before, until the tank is totally full. This will bring the water volume to 9600 gallons. The weight of this water is within 1000 pounds of the design load condition and is satisfactory for this trial.

Step 32: Add water to the forward trim tank, as before, until a total of 31.00 long tons is reached. This weight is equivalent to 8325 gallons and will bring the water level in the tank to 5' - 11" inches as measured through the sounding tube.

Step 33: Take trim measurements with Dumpy level and log results.

3.5 SIMULATION OF SURFACE MOORING WITH BOW VERTICAL LEG

The simulation of the *SQUAW* moored on the surface with both bow and stern mooring lines and the bow vertical leg installed is to be run. To simulate this condition, total mooring forces and weights equal 42.66 long tons with the load distributed toward the bow.

Step 34: The water level in the stern trim tank must be lowered so that the tank holds 11.66 long tons for vertical force simulation plus the original 5.13 long tons of ballast. This weight is equivalent to 4510 gallons of fresh water and will bring the water level inside the tank to 4' - 4 1/2" as measured through the sounding tube. The gasoline powered pump is to be used to remove water from the tank.

Step 35: Insure that the bow trim tank's water level is 5' - 11 inches.

Step 36: Take trim measurements with the Dumpy level and log results.

4.0 FINAL PREPARATIONS FOR MOOR

The final steps in the buoyancy and trim trials include securing the *SQUAW* for the final mooring operation. All trim tanks will be loaded to their final configuration.

Step 37: Blow all main ballast tanks in the following order; 1 & 2, 9 & 10, 3 & 4, and 5 & 6.

Step 38: Empty the forward trim tank using a gasoline powered pump with discharge over the side. Check that tank is empty with dip stick through sounding tube.

Step 39: Reduce the water level in the after trim tank until its depth is 3' - 1". This level corresponds to 1380 gallons of fresh water or 5.13 long tons.

Step 40: Replace the 2 1/2-inch valves on each trim tank. Replace caps on sounding tubes. Pump any water from compartments above trim tanks. Insure that all valves are closed on each of the two trim tanks.

Step 41: Seal inner hatch cover above after trim tank. Thoroughly clean flange face inside trunk, flange of inner hatch cover and rubber gasket (both sides). Align gasket over bolt pattern, install hatch cover and bolts using the pneumatic wrench.

Step 42: Install the pressure reducing regulator in line with the pier air supply and connect the supply hose to the hatch cover by removing the 3/4 inch pipe plug. Pressurize the compartment with 2 to 3 psi by adjusting the regulator. Secure the air flow and test the seal using liquid leak detector. Insure that no leaks are present. Remove the hose and allow the compartment to vent. Replace the pipe plug with Teflon tape for sealing.

Step 43: Install a 20-pound zinc anode inside the trunk. This anode must be electrically connected to the hatch cover. Use of short electrical conductor and clamp to hatch handle. The zinc can be lashed to the handle.

Step 44: Thoroughly clean the outer flange on the trunk. Clean the mating flange on the outer hatch cover and both faces of the rubber gasket. Align the gasket to the bolt hole pattern of the flange, and install the hatch cover with bolts with the pneumatic wrench.

Steps 45, 46, 47, and 48: Repeat steps 41, 42, 43, and 44 for the forward trim tank.

Step 49: Make a final check to insure that all main ballast tanks are void by blowing each tank and observing escaping air from under the tank.

Step 50: Secure all deck valves on the ballast manifold.

5.0 RESPONSIBILITIES -- TEST PERFORMANCE

Responsibility for the *SQUAW* Trim and Buoyancy Test is to be divided into two major areas. The two categories include test performance and equipment provision.

Two representatives of CHESNAVFACENGCOM will be responsible for the test condition with support provided by PWC San Diego. All equipment will be provided by PWC San Diego.

5.1 TEST PERFORMANCE

The procedures outlined in this plan will be followed under the direction of CHESDIV personnel. In addition, one person from PWC is to assist in the conduction of the trials, taking measurements and logging results.

Additionally, two PWC personnel are required to support the trials. Requirements of these personnel will include hatch removal and refitting, valve removal, hose connection, pump operation, and general support. These personnel should be available full time during the week of the trials. Additional support is required by PWC for the provision and operation of a crane to lift a ten-ton weight from the pier to the *SQUAW* deck and to offload some miscellaneous equipment presently loaded on the *SQUAW*.

5.2 EQUIPMENT

All equipment delineated in Appendix B is to be provided by PWC to support the trials.

5.3 SCHEDULE -- SQUAW TRIM AND BUOYANCY TRIALS

Monday, 23 January

0730
- o Inventory all material pierside, check fitting sizes with hoses (air, F. W., etc.)
- o Remove man-way covers (Step 1)

	o	Fit air supply hoses (Steps 2 and 3)
	o	Remove miscellaneous hardware (Step 4) (NOTE: CRANE REQUIRED)
1230	o	Measure, adjust and log trim tank levels (Steps 5, 6, and 7)
1430	o	Set up Dumpy level, log baseline measurements
	o	Blow all ten ballast tanks
	o	Take trim measurements, log data (Steps 8, 9, and 10)
	o	Secure test by closing all valves and replacing all hatches (4 bolts each)

Tuesday, 24 January

0730	o	Flood ballast tanks sequentially (Steps 11, 12, 13, and 14)
	o	Take measurements and log data
	o	Bow tanks 7 and 8 (Step 15)
1230	o	Load FWD trim tank with 3130 gal of F.W.
	o	Take measurements and log results (Steps 16 and 17)
1430	o	Load aft trim tank with additional 313 gal of F.W.
	o	Take measurements and log results (Steps 18 and 19)
	o	Replace all hatches and close all valves (secured for night)

Wednesday, 25 January

0730	o	Remove 4 hatches
	o	Add 1270 gal of F.W. to stern tank
	o	Add 1270 gal of F.W. to FWD tank
	o	Rig deck valves for pierside control of ballast tanks 7 and 8
	o	Install gaskets and hatches
	o	Flood tanks 7 and 8
	o	(Steps 20, 21, 22, 23, 24, and 25)
1230	o	Rig ten-ton weight for lift to *SQUAW* deck (NOTE: CRANE, WEIGHT AND TENSIONMETER REQUIRED)
	o	Slowly transfer weight to *SQUAW*
	o	Log final tensionmeter reading
	o	Remove weight and take measurements (Steps 26 and 27)
	o	Blow ballast from tanks 7 and 8 and secure for night (Step 28)

Thursday, 26 January

0730	o	Verify that tanks 7 and 8 are void (Step 29)
	o	Remove all four hatch covers
	o	Add 3820 gal of F.W. to stern tank (tank full)
	o	Add 3925 gal of F.W. to FWD tank
	o	Take measurements and log data (Steps 30, 31, 32, and 33)
1230	o	Remove 5090 gal of F.W. from stern tank with pump
	o	Check level in stern tank
	o	Take measurements and log data (Steps 34, 35, and 36)
1430	o	Blow all main ballast tanks
	o	Empty FWD trim tank with pump (Steps 37 and 38)
	o	Replace all hatches and secure for night

Fr. ay, 27 January

0730	o	Remove all hatches
	o	Remove 8220 gal of F.W. from aft trim tank
	o	Replace trim tank valves
	o	Seal inner hatch covers above aft tank
	o	Pressurize the tank and check for leaks
	o	Install zinc anode
	o	Replace outer hatch cover (Steps 39, 40, 41, 42, 43, and 44)
1230	o	Seal inner hatch cover above FWD tank
	o	Pressurize the tank and check for leaks
	o	Install zinc anodes
	o	Replace outer hatch cover (Steps 45, 46, 47, and 48)
1530	o	Insure that all ballast tanks are voided
	o	Secure all deck valves

SQUAW TRIM AND BUOYANCY TEST ANALYSIS

PREPARED BY
ROBERT TAGGART INCORPORATED
FAIRFAX, VIRGINIA 22031
MAY 1978

1.0 VARIATIONS FROM THE PLANNED TEST PROCEDURE

As may be noted in Step 9 of the foregoing test plan it was intended to blow all main ballast tanks in order to establish a rational sequence of tests to ascertain the trim and buoyancy condition of *SQUAW*. This plan was thwarted by the fact that during its last overhaul, all of the main ballast tank openings along the keel had been fitted with bolted cover plates that were not easily accessible in the test location at the Naval Repair Facility, San Diego.

The tests were scheduled to start on 23 January 1978 at which time the ballast tank condition noted above was discovered. Divers were called upon to remove the cover plates but this was found to be a more difficult task than anticipated. As a result, it was decided to rework the test procedure so as to minimize the number of tanks from which cover plates would be removed. Calculations indicated that a fairly representative test could be conducted with only Tanks 5, 6, 7, and 8 opened at the bottom to the sea. Therefore, divers were dispatched to remove the cover plates from these four tanks.

In the meantime, the test program was revised to conduct some eleven tests intended to simulate the various conditions that would be encountered during the *SQUAW* mooring operations. These tests are arbitrarily denoted below by lower case Arabic letters followed by the date and time when the tests were conducted; these are followed by a description of the tank conditions applicable to each test. When it is noted that ballast tanks 5 & 6 or 7 & 8 were *void*, this condition was obtained by blowing the tanks from the vent piping system until air bubbles appeared alongside the submarine. When *free flood* of these four tanks is indicated the vents were opened and checked for sound of escaping air.

a. 1/25/78 - 0840: All ballast tanks void; after trim tank carrying 5.13 tons of fresh water.

b. 1/25/78 - 1218: Ballast tanks 1 & 2 pressed up with salt water; all other ballast tanks void; 5.13 tons in after trim tank.

c. 1/25/78 - 1630: Ballast tanks 1, 2, 9, & 10 pressed up with salt water; all other ballast tanks void; 5.13 tons in after trim tank.

d. 1/26/78 - 0930: Ballast tanks 1, 2, 3, 4, 9, & 10 pressed up with salt water; ballast tanks 5, 6, 7, & 8 blown void; 5.13 tons in after trim tank.

e. 1/26/78 - 1010: Ballast tanks 1, 2, 3, 4, 9, & 10 pressed up with salt water; ballast tanks 5 & 6 free flooded to outside waterline; ballast tanks 7 & 8 void; 5.13 tons in after trim tank.

f. 1/26/78 - 1100: Ballast tanks 1, 2, 3, 4, 9, & 10 pressed up with salt water; ballast tanks 5 & 6 blown void; ballast tanks 7 & 8 free flooded to outside waterline; 5.13 tons in after trim tank.

g. 1/26/78 - 1150: Ballast tanks 1, 2, 3, 4, 9, & 10 pressed up with salt water; ballast tanks 5 & 6 blown void; ballast tanks 7 & 8 free flooded to outside waterline; 5.13 tons in after trim tank; 11.66 tons in forward trim tank.

h. 1/26/78 - 1250: Ballast tanks 1, 2, 3, 4, 9, & 10 pressed up with salt water; ballast tanks 5 & 6 blow void; ballast tanks 7 & 8 free flooded to outside waterline; 16.82 tons in after trim tank; 11.66 tons in forward trim tank.

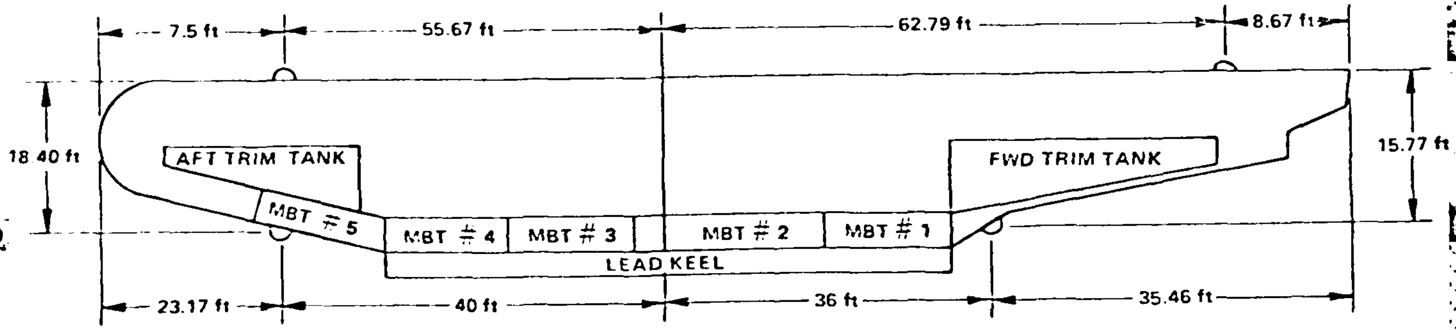
i. 1/26/78 - 1445: Ballast tanks 1, 2, 3, 4, 9, & 10 pressed up with salt water; ballast tanks 5 & 6 blown void; ballast tanks 7 & 8 free flooded to outside waterline; 21.51 tons in after trim tank; 16.38 tons in forward trim tank.

j. 1/27/78 - 0900: Same conditions as Test i.

k. 1/27/78 - 0945: Ballast tanks 1, 2, 3, 4, 9 & 10 pressed up with salt water; ballast tanks 5, 6, 7 & 8 free flooded to outside waterline; 21.51 tons in after trim tank; 16.38 tons in forward trim tank.

2.0 TEST PROCEDURE

At the commencement of the test program the Dumpy level was set up on the pier to which the *SQUAW* was loosely secured. The telescope of the instrument was set at a height of 5' - 1" above the pier and carefully leveled so that it would read the same altitude above the waterline at all angles of swing at a given tide height. It could then be turned to read the height on a leveling rod posted at set positions on the deck of the *SQUAW* forward, amidships, and aft. The points selected fore and aft where doubler plates were provided for padeyes on the deck. The fore and aft location of these points was indicated on available drawings of the ship with respect to the bow and stern as shown in Figure A-2, taken from NAVSHIPS 0994-011-2010, the 1971 report of the most recent *SQUAW* mooring operation.



CONFIGURATION OF SQUAW

FIGURE A-2

This report also located the submerged longitudinal center of buoyancy as being 1.8 feet aft of the amidship section. The midship reading was taken at this point. These three measurement points are shown more specifically in Figure A-3 and in the text that follows the readings recorded will be designated as the elevations of the Dumpy level above the deck at Bow, ℄, and Stern.

3.0 TEST RESULTS AND THEIR ANALYSIS

The three measured elevations and the corresponding height of the

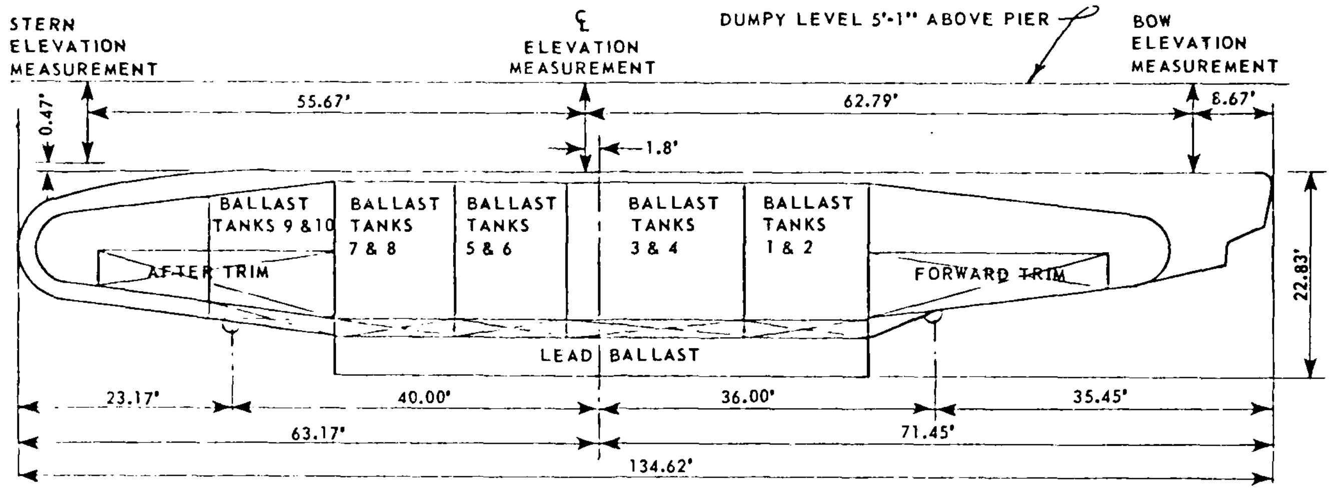


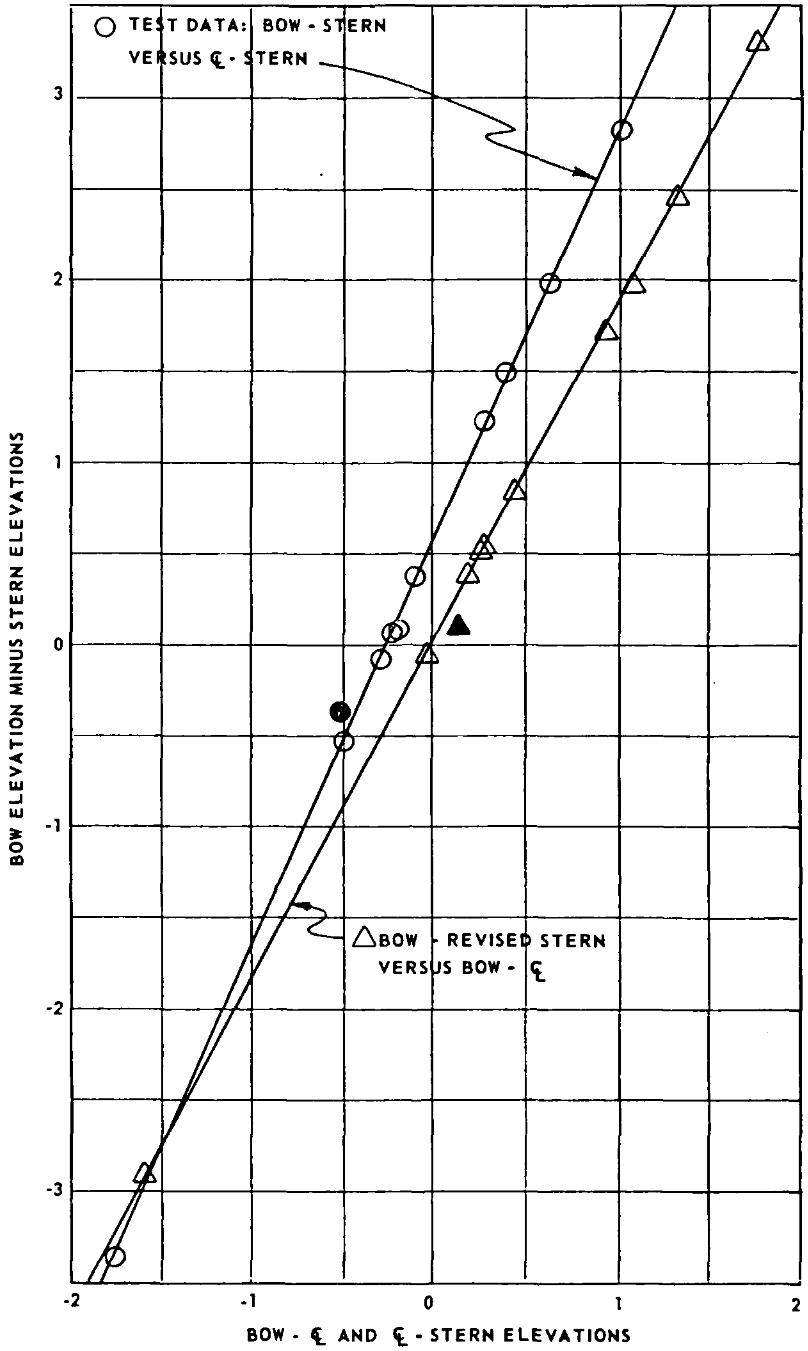
DIAGRAM OF SQUAW FOR USE IN TRIM AND BUOYANCY TEST ANALYSIS

FIGURE A-3

Dumpy level above the waterline are tabulated below for the eleven test conditions described earlier:

Test	Bow Elevation	℄ Elevation	Stern Elevation	Dumpy Level Above W. L.
a	3.04	2.90	3.41	10.50
b	8.37	6.61	5.56	13.00
c	11.19	10.92	11.10	16.83
d	7.16	5.83	5.18	10.50
e	7.81	6.71	6.31	10.50
f	7.09	7.13	7.62	11.00
g	9.18	8.23	7.95	11.83
h	9.88	9.69	9.96	13.17
i	12.85	12.40	12.49	15.67
j	8.35	8.06	8.28	11.33
k	7.57	9.18	10.96	10.92

At the time when these test results were first analyzed, the fore and aft location of the ℄ elevation measurement point and the height of the stern elevation measurement point were not known. It was known, however, that the bow and ℄ measuring points were on a level deck parallel to the keel, and the fore and aft distance between bow and stern measuring points was known. To determine these two unknown values, the differences between bow and stern elevations were plotted against the differences between ℄ and stern elevations as shown in Figure A-4.



PLOTS OF DIFFERENCES IN TEST DATA ELEVATION READINGS

FIGURE A-4

With the exception of one point from Test a. these plotted differences fitted quite precisely a straight line with the equation:

$$(\text{Bow - Stern elevation}) = 0.56 + 2.185\ (℄ - \text{Stern elevation})$$

At even keel the difference between bow and stern elevations should equal the difference between ℄ and stern elevations. Using this equality it could be determined that the measurement point at the stern was 0.473' lower than the deck level to which the other measurements were made. All stern elevations were reduced accordingly. The other set of points in Figure A-4 comprises a plot of the differences between the bow and revised stern elevations versus the difference between bow and centerline elevations. It can be noted that this line has a slope of 0.545 and passes through the origin. This indicates that the ℄ measuring point is 0.545 times the distance between bow and stern measuring points which matches the geometry given in Figure A-3.

The solid spots in Figure A-4 which fall off the two lines indicate an obvious error in one of the three readings for Test a. This could, of course, have been any one of the three but it is found on analysis and comparison with the other test data that the stern elevation should probably have been 3.26 instead of 3.41.

The next item of information required to analyze the test results was a set of Hydrostatic Curves or Curves of Form for *SQUAW*. These were obtained from the report of the 1976 mooring operation, NAVSHIPS 0994-011-2010 and converted to usable form based on the draft to the bottom of the fixed ballast, 22.83 feet below the superstructure deck. These working hydrostatic curves are given in Figure A-5.

Since some of the tests were conducted with free flooding of either Ballast Tanks 5 & 6 or of 7 & 8 it was necessary to know the weight of water that would be flooded into these tanks at any given draft of the ship. Although data on the total ballast tank capacities were available there were no data that gave actual capacity curves. Since these wrap-around ballast tanks occupy the space between two concentric cylinders of known dimensions it was relatively simple to calculate their capacity curves. These are given in Figure A-6.

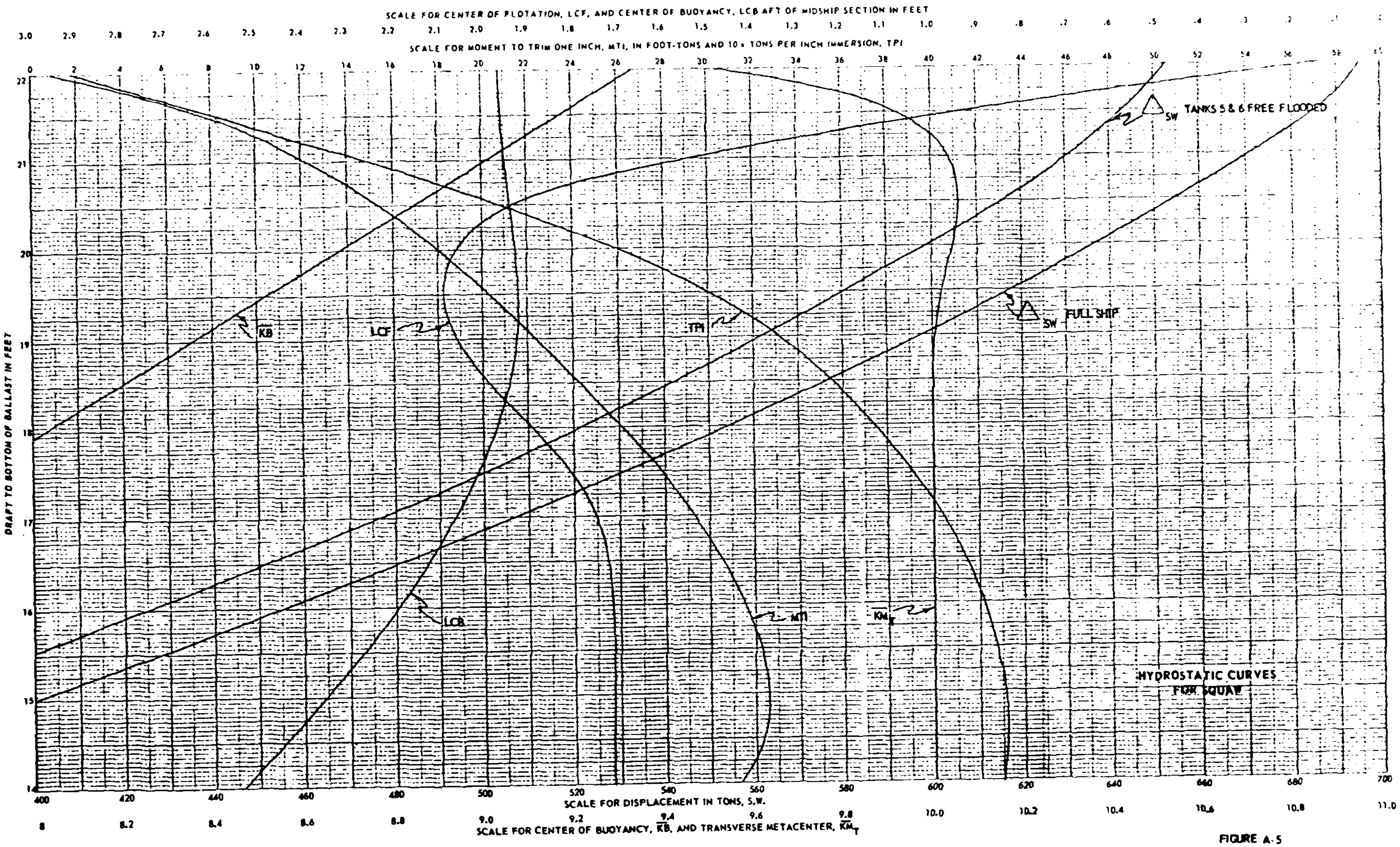
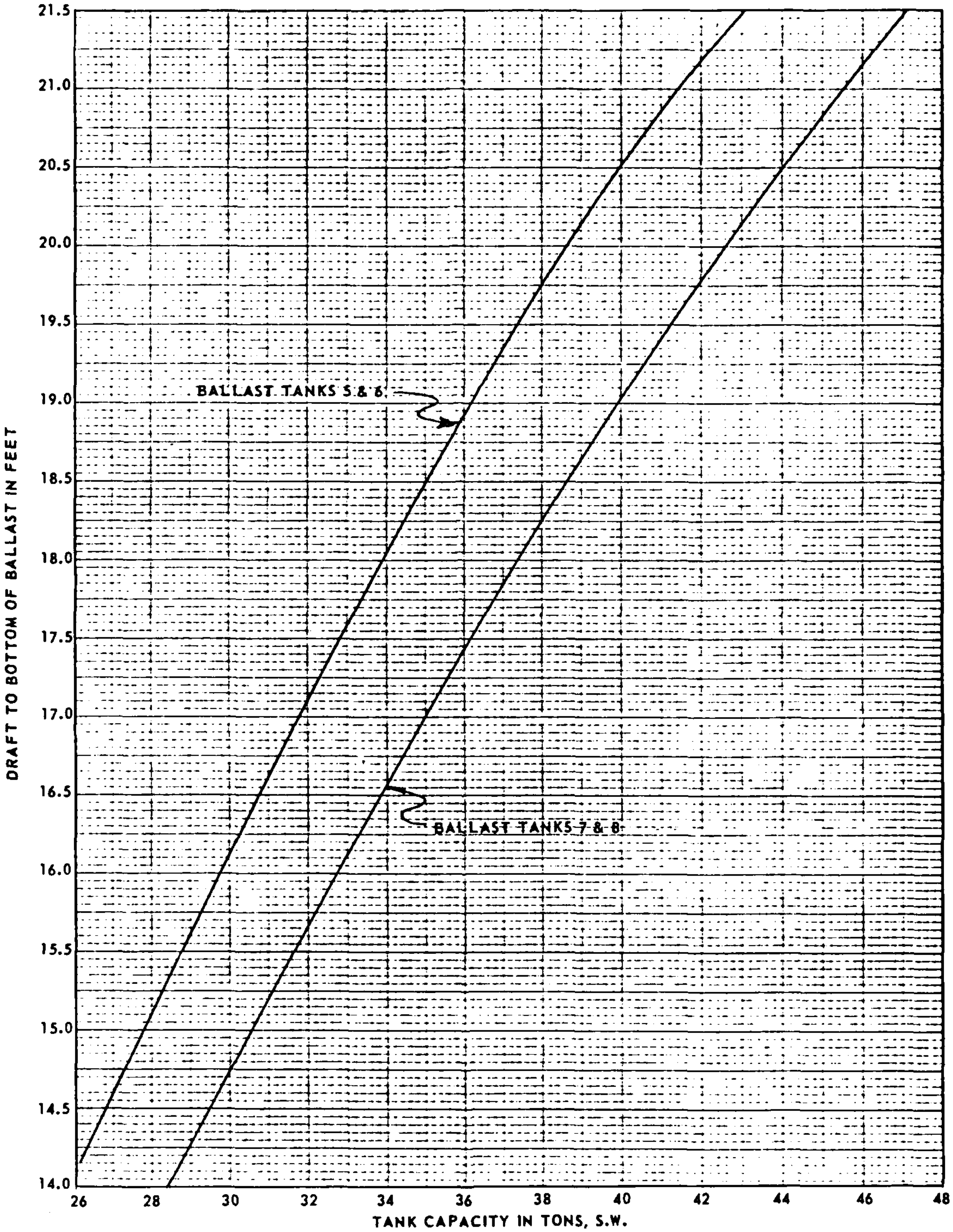

SCALE FOR CENTER OF FLOTATION, LCF, AND CENTER OF BUOYANCY, LCB AFT OF MIDSHIP SECTION IN FEET
SCALE FOR MOMENT TO TRIM ONE INCH, MT1, IN FOOT-TONS AND 10 x TONS PER INCH IMMERSION, TPI
DRAFT TO BOTTOM OF BALLAST IN FEET
SCALE FOR DISPLACEMENT IN TONS, S.W.
SCALE FOR CENTER OF BUOYANCY, $\overline{KB}$, AND TRANSVERSE METACENTER, $\overline{KM}_T$
$\overline{KB}$
LCF
TPI
LCB
MT1
$\overline{KM}_T$
SW TANKS 5 & 6 FREE FLOODED
SW FULL SHIP
HYDROSTATIC CURVES
FOR SQUAW

FIGURE A-5



FREE FLOODING CAPACITY OF SQUAW BALLAST TANKS

FIGURE A-6

It may be noted from the hydrostatic curves that the longitudinal center of flotation varies between 1.7 and 2.1 feet abaft the midship section. Thus the ℄ measurement taken at 1.8 feet abaft the midship section was a reasonably reliable elevation at the LCF about which the ship trims. From the difference between the bow and stern elevation readings, the trim of the ship for each condition could be obtained. Total trim was this difference multiplied by the ratio of the overall length of the ship to the distance between bow and stern measuring points, i.e., 134.62/118.46 = 1.136. For convenience and consistency the trim will be considered positive when the bow is higher than the stern and negative when the ship is down by the head.

The purpose of this analysis is to determine the basic condition of the *SQUAW* after its last overhaul with regard to weight and the longitudinal center of gravity of the ship in the light ship condition. This is needed as a basis for calculating draft and trim during each phase of the mooring operations. In this case the light ship weight is defined as the base hull weight with trim and ballast tanks empty and with no other gear aboard. Since the tests were conducted with only liquid added to the light ship condition, the light ship weight can be obtained by subtracting the weight of the liquids from each displacement of the ship at each test condition.

Total ballast tank capacities when pressed up with salt water and their corresponding centers of gravity from the midship section are as follows:

Ballast Tanks	Weight, Tons	LCG (+ fwd.)
1 & 2	48.03	+ 22.35
3 & 4	69.85	+ 6.04
5 & 6	43.65	- 9.67
7 & 8	48.03	- 22.35
9 & 10	36.81	- 35.60

Taking the test conditions previously described, the total ballast weight and center for each condition can be derived. It may be noted that while the center of gravity of liquids in the ballast tanks is constant for all conditions the center of gravity of liquid in the trim tanks varies with capacity because of the shape of the tank. The eleven test ballast conditions are as follows:

Test	F. W. Ballast Weight	F. W. Ballast LCG	S. W. Ballast Pressed Up Weight	S. W. Ballast Pressed Up LCG	Free Flood S. W. Ballast Weight	Free Flood S. W. Ballast LCG	Total Ballast Weight	Total Ballast LCG
a	5.13	- 34.21	0	-	0	-	5.13	- 34.21
b	5.13	- 34.21	48.03	+ 22.35	0	-	53.16	+ 16.89
c	5.13	- 34.21	84.84	- 2.79	0	-	89.97	- 4.84
d	5.13	- 34.21	154.69	+ 1.20	0	-	159.22	+ 0.07
e	5.13	- 34.21	154.69	+ 1.20	36.40	- 9.67	195.64	- 1.75
f	5.13	- 34.21	154.69	+ 1.20	39.64	- 22.35	198.87	- 4.40
g	16.79	+ 14.07	154.69	+ 1.20	40.50	- 22.35	211.98	- 2.28
h	28.48	- 7.55	154.69	+ 1.20	40.65	- 22.35	223.82	- 4.19
i	37.89	- 6.15	154.69	+ 1.20	41.30	- 22.35	233.88	- 4.15
j	37.89	- 6.15	154.69	+ 1.20	41.30	- 22.35	233.88	- 4.15
k	37.89	- 6.15	154.69	+ 1.20	87.10	- 16.31	279.68	- 5.25

In order to ascertain the ship displacement and longitudinal center of gravity for each test condition, the hydrostatic curves are used. From the displacement curve the weight, Δ_{SW} for each LCF draft is read off. Then, at this draft, the longitudinal center of buoyancy, LCB, and the moment to trim one inch, MTI, are obtained. The trim measured during the test multiplied by the MTI gives the total moment required to trim the ship from even keel to the trim condition that was measured. When this moment is divided by the displacement it gives the trimming moment arm; this is the distance between the center of the upward acting buoyancy force and the downward acting weight of the vessel. From the evel keel location of the LCB it is then possible to obtain the center of gravity for the condition, LCG. Then knowing the weight and center of gravity of the ship in the test condition and the weight and center of gravity of the ballast, the light ship weight and its longitudinal center can be obtained. These calculations are tabulated below.

Test	℄ Elevation	Dumpy Level Above WL	Draft at LCF	Trim Feet	Ship in Test Condition Δ_{SW}	Ship in Test Condition *LCG
a	2.90	10.50	15.23	- 0.114	412.7	- 2.047
b	6.61	13.00	16.44	- 3.728	478.4	+ 0.717
c	10.92	16.83	16.92	- 0.636	503.4	- 2.017
d	5.83	10.50	18.16	- 2.784	563.0	- 0.453
e	6.71	10.50	19.04	- 2.239	599.4	- 0.939
f	7.13	11.00	18.96	+ 0.068	595.9	- 1.956
g	8.73	11.83	19.23	- 1.932	606.7	- 1.115
h	9.69	13.17	19.35	- 0.443	611.5	- 1.745
i	12.40	15.67	19.56	- 0.943	620.0	- 1.569
j	8.06	11.33	19.56	- 0.614	620.0	- 1.695
k	9.18	10.92	21.21	+ 3.319	678.7	- 2.570

*Derived in following Table

Continuing the calculation and subtracting ballast.

Test	Ship in Test Condition MTI Ft. Tons	Ship in Test Condition Moment Arm, Ft.	Ship in Test Condition LCB Ft.	Ship in Test Condition LCG Ft.	Test Ship - Ballast Light Weight	Test Ship - Ballast Ship LCG
a	32.4	0.268	- 2.315	- 2.047	407.6	- 1.642
b	30.5	2.852	- 2.135	+ 0.717	425.2	- 1.305
c	29.4	0.058	- 2.075	- 2.017	413.4	- 1.403
d	25.4	1.507	- 1.960	- 0.453	403.8	- 0.660
e	22.0	0.986	- 1.925	- 0.939	403.8	- 0.546
f	22.3	- 0.031	- 1.925	- 1.956	397.0	- 0.732
g	21.2	0.810	- 1.925	- 1.115	394.7	- 0.489
h	20.7	0.180	- 1.925	- 1.745	387.7	- 0.333
i	19.8	0.361	- 1.930	- 1.569	386.1	- 0.006
j	19.8	0.235	- 1.930	- 1.695	386.1	- 0.208
k	10.4	- 0.610	- 1.960	- 2.570	399.0	- 0.692

The overall average for all of these test results is a light ship weight of 400.40 tons with the longitudinal center of gravity at 0.741 feet abaft the midship section. This can be compared with a light ship weight of 409.55 tons given in NAVSHIPS 0994-011-2010.

It does not appear logical that the *SQUAW* could have lost nine tons of weight during its last submergence or during overhaul at the Long Beach Naval Shipyard. The only overhaul item that could possibly cause a weight reduction was the replacement of 334 square feet of superstructure deck changing from perforated plate to grating which could mean a maximum reduction of less than one ton. Therefore it appears that a closer look at the test data may be in order.

At a first look, Test b appears to be out of line with other early tests. This indicates an error and it is believed that these results should be omitted from the averaging. Secondly, Test k is questionable since the hydrostatic curves are not particularly reliable at the keel depth at which these readings were made.

Finally, it may be noted that in Tests f through j the calculated light ship weight has dropped significantly. When looking at the revised test agenda it is found that in all of these tests, Ballast Tanks 7 & 8 were supposedly free flooding. It is of interest to postulate that a vent valve closure might have resulted in only one of this pair free flooding while the other remained empty. To test this hypothesis, the weight of half of this pair of tanks can be added back in to the derived light ship weight with the following results:

	Calculated Light Ship		1/2 Tanks 7 & 8		Revised Light Ship	
Test	Weight	LCG	Weight	LCG	Weight	LCG
f	397.0	- 0.732	19.83	- 9.67	416.8	- 1.157
g	394.7	- 0.489	20.20	- 9.67	414.9	- 0.936
h	387.7	- 0.333	20.35	- 9.67	408.1	- 0.799
i	386.1	- 0.006	20.62	- 9.67	406.7	- 0.496
j	386.1	- 0.208	20.62	- 9.67	406.7	- 0.688

These revised light ship results compare quite favorably with those of Tests a, c, d, and e indicating that non-flooding of Ballast Tank 7 or 8 was indeed a possibility during the tests conducted in January 1978.

CONCLUSIONS AND RECOMMENDATIONS

If then, we take the average values derived from Tests a, c, d, e and the corrected values from f, g, h, i, and j the result is a light ship weight of 409.1 tons with a longitudinal center of gravity 0.93 feet abaft the midship section. It is concluded that these values are conservatively representative of the data obtained from the *SQUAW* Trim and Buoyancy Tests and it is recommended that they be used as a basis for calculating the various operational conditions that will be encountered during the *SQUAW* mooring activities.

Because of the uncertainty regarding the venting of Ballast Tanks 7 & 8 it is strongly recommended that all tanks to be free flooded during the mooring operation be thoroughly checked for proper action of the vents and flooding openings before the ship leaves the pier.

APPENDIX B

PRELIMINARY ANALYSIS OF SQUAW MOORING TRIM AND BUOYANCY CONTROL

INTRODUCTION

It is planned to moor the *SQUAW* in 6000 feet of water off San Diego at the end of June 1978. A set of Trim and Buoyancy Tests were conducted on this vessel in January 1978 in order to yield trim and buoyancy data that could be used in the mooring operations. These tests have recently been reevaluated and it appears that the conclusions drawn therefrom were optimistic. If the *SQUAW* mooring operations were to be conducted in accordance with the planned procedure it is conceivable that the results might not be as planned. Therefore, a series of alternative mooring procedures have been tested to evolve a safer and more successful mooring operation. These alternatives are reported herein and a recommended procedure is given.

PURPOSE OF THIS REPORT

Since the steps recommended herein have already been taken, this report serves only as a back-up justification for making the recommendations. It will therefore be assumed that the reader is acquainted with the *SQUAW* and the general mooring concept. For ready reference it might be stated here that the *SQUAW* has a cylindrical pressure hull with conical ends, inside which are contained a forward trim tank and an after trim tank. Wrapped around the hull are five pairs of ballast tanks numbered from bow to stern, the starboard tanks numbered 1, 3, 5, 7, and 9 and the corresponding port tanks numbered 2, 4, 6, 8, and 10. These ballast tanks must be completely filled on submergence.

PREVIOUSLY PLANNED PROCEDURE

Prior to the trim and buoyancy test it was found that cover plates had been bolted to the bottom inlets to all ballast tanks; thus they were no longer free flooding nor could they be blown out for buoyancy. The covers were removed on Tanks 5, 6, 7, & 8 so these tanks could be used to contain variable quantities of ballast for the test. Also some 5.13 tons of fresh water were inserted in the after trim tank for all tests since this was a quantity that had been used during previous moorings.

Although all of the ballast tanks were progressively filled during the trim and buoyancy test, with draft and trim being measured for each condition, only one of these tests was used as a basis for deriving the buoyancy control procedure for the mooring operations. The conditions for this particular test were that Tanks 1, 2, 3, 4, 9, & 10 were pressed up with sea water, 5, 6, 7, and 8 were blown empty, and 5.13 tons of fresh water was contained in the after trim tank. Upon recalculation it was found that this test on which mooring procedures were based gave slightly erroneous results when compared with the other tests conducted. For example, when reduced to light ship conditions the basic test gave a light ship weight of 403.2 tons with a longitudinal center of gravity 0.60 feet abaft amidships whereas the best average of all available data was a light ship weight of 409.1 tons with a center of gravity 0.93 feet abaft amidships. Additionally, the estimates of mooring system vertical loads on the submarine have been revised since the initial calculations were made and the order in which the mooring lines were to be lowered has also been changed. There still remains some question as to whether the bow and stern mooring legs will be pulled out to the final spread before the vertical anchor legs are lowered.

REANALYSIS OF MOORING PROCEDURES

Based upon more recent data on the mooring system vertical loads, and using the average light ship condition mentioned above, each possible step of the mooring procedure has been recalculated for a number of buoyancy control options. These options are designated by lower case Arabic letters as follows:

a. Covers remain on and Ballast Tanks 1, 2, 3, 4, 9, and 10 are pressed up with sea water; Ballast Tanks 5, 6, 7, and 8 are blown empty; after trim tank contains 5.13 tons of fresh water.

b. Same as a. above except Ballast Tanks 7 and 8 are allowed to free flood as the ship sinks deeper in the water.

c. Covers are removed from Ballast Tanks 3 and 4 and Tanks 3, 4, 5, 6, 7, and 8 are blown empty; Ballast Tanks 1, 2, 9, and 10 remain covered and are pressed up with salt water; after trim tank contains 5.13 tons of fresh water.

d. Same as c. above except that Ballast Tanks 5 and 6 are allowed to free flood as the ship sinks deeper in the water.

The various mooring system loading conditions that were analyzed for each of the above ballast options are designated by Roman numerals as follows:

I Towing condition - no lines aboard

II Bow mooring line out with anchor on bottom and line slack

III Bow mooring line out and pulled taut to set anchor

IV Bow and stern mooring lines out with anchors on bottom and lines slack

V Bow and stern mooring lines both pulled taut with anchors in final position

VI Bow and stern mooring lines slack with forward anchor leg suspended

VII Bow and stern mooring lines slack with forward and after anchor legs suspended

VIII Bow and stern mooring lines taut with forward anchor leg suspended

IX Bow and stern mooring lines taut with forward and after anchor legs suspended

X Ship submerged just below surface

XI Ship in final position submerged to 300 foot depth

For the nine mooring system loading conditions with the *SQUAW* on the surface, the calculated bow and stern drafts are tabulated below.

DRAFT IN FEET AT BALLAST OPTIONS

	a		b		c		d	
MOORING SYSTEM LOADING	BOW	STERN	BOW	STERN	BOW	STERN	BOW	STERN
CONDITION I	19.69	17.25	19.11	19.58	17.26	16.58	17.47	17.62
CONDITION II	20.94	16.56	20.50	18.74	18.34	15.95	18.52	17.02
CONDITION III	22.03	15.93	21.70	17.97	19.08	15.55	19.43	16.51
CONDITION IV	20.29	17.42	19.66	19.85	17.68	16.78	17.92	17.85
CONDITION V	20.83	17.53	20.15	20.09	18.04	16.92	18.31	18.05
CONDITION VI	22.57	16.41	22.26	18.65	19.39	16.10	19.78	17.19
CONDITION VII	21.78	18.07	20.76	21.22	18.51	17.63	18.82	18.93
CONDITION VIII	23.30	16.42	23.07	18.57	19.80	16.26	20.78	17.33
CONDITION IX	22.30	18.18	21.16	21.78	17.92	19.06	19.26	19.11

When it is noted that the draft from the bottom of the ballast to the top of the ballast tanks is 21.79 feet and to the top of the pressure hull is 22.01 feet it becomes quite obvious how critical some of the above surfaced conditions are. Specifically longitudinal stability is greatly reduced when the forward end of the hull submerges. In Condition III a, with only a bow mooring line out and the forward deck awash, it is quite possible that the *SQUAW* would be upended with bow down.

Although allowing Tanks 7 and 8 to free flood as in Ballast Option b. reduces somewhat the drastic trim of Option a.,the *SQUAW* would still assume several potentially dangerous attitudes during the mooring operations and therefore this solution is not acceptable.

In Ballast Option c., with Ballast Tanks 3, 4, 5, 6, 7, and 8 all blown empty there is ample freeboard throughout the operation. However, in towing to the site the ship would be down by the head which is not particularly desirable and during the various mooring loading conditions the trim changes quite drastically. By free flooding Ballast Tanks 5 and 6, as in Option d., these objectionable features can be overcome while still maintaining adequate freeboard for safety.

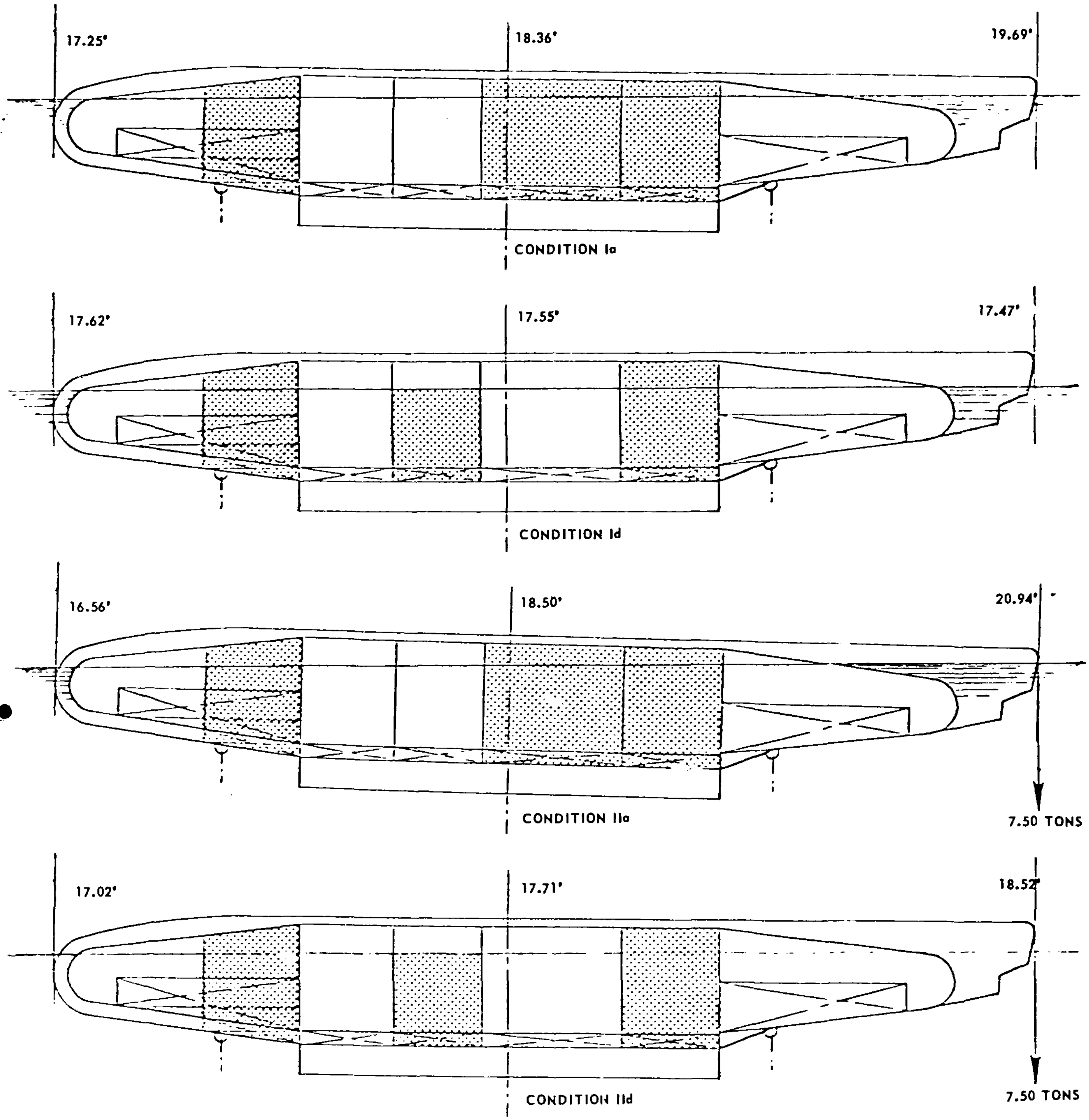
In submerged Condition X, just as the *SQUAW* sinks below the surface, the negative buoyancy would be 30.54 tons. This is rather excessive compared with the 7.94 tons used in the last mooring operation. Although there is no specific criterion against which this can be judged, it appears that the negative buoyancy is a bit excessive. The centers of gravity and buoyancy are close enough together so that no excessive trim should be encountered.

There is, however, cause for alarm in the fully submerged Condition XI. When the 25 ton weight of the anchor clumps is removed, and the mooring line weight is reduced by some 6 tons, the reserve buoyancy is reduced to 0.13 tons which is entirely unsatisfactory since with a slight miscalculation, the *SQUAW* could sink well below her collapse depth.

The results of some of these calculations are shown graphically on the following five pages. These drawings show the forces acting on the *SQUAW* and the resulting draft and trim conditions for all mooring system loading conditions for Ballast Options a. and d.

RECOMMENDATIONS

As a result of this series of calculations it is believed absolutely essential that changes be made in the planned procedure for mooring *SQUAW* during the June 1978 operations. These are:

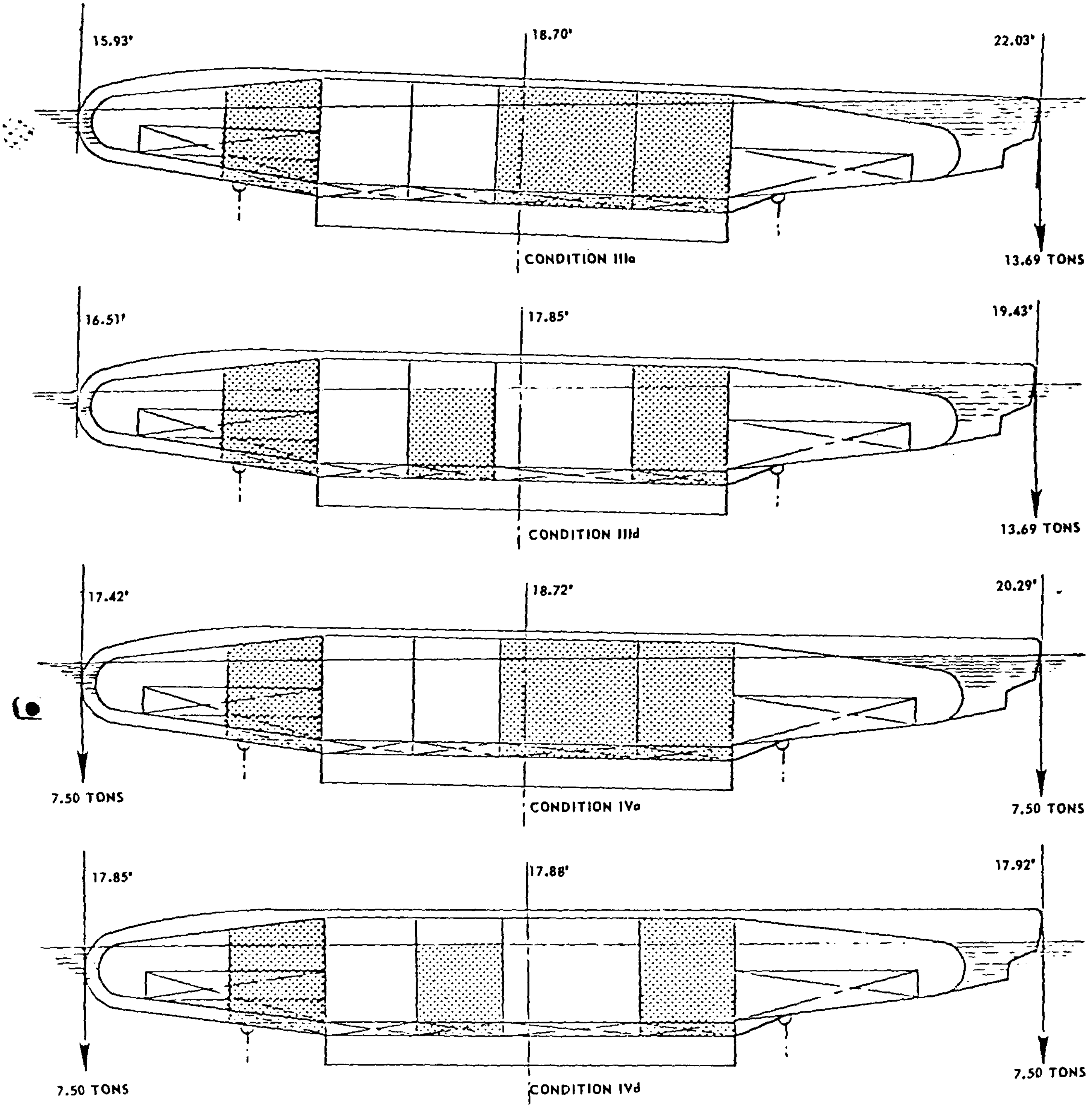


CONDITION I - TOWING

CONDITION II - BOW MOORING LINE SLACK

a. BALLAST TANKS 1, 2, 3, 4, 9, & 10 PRESSED UP; TANKS 5, 6, 7, & 8 VOID

d. BALLAST TANKS 1, 2, 9, & 10 PRESSED UP; TANKS 3, 4, 7, & 8 VOID; 5 & 6 FREE FLOODING

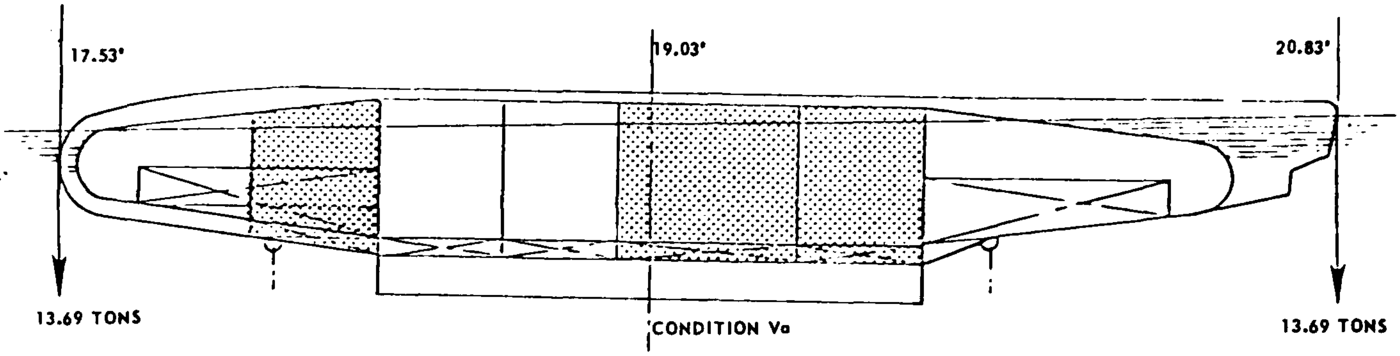


CONDITION III - BOW MOORING LINE TAUT

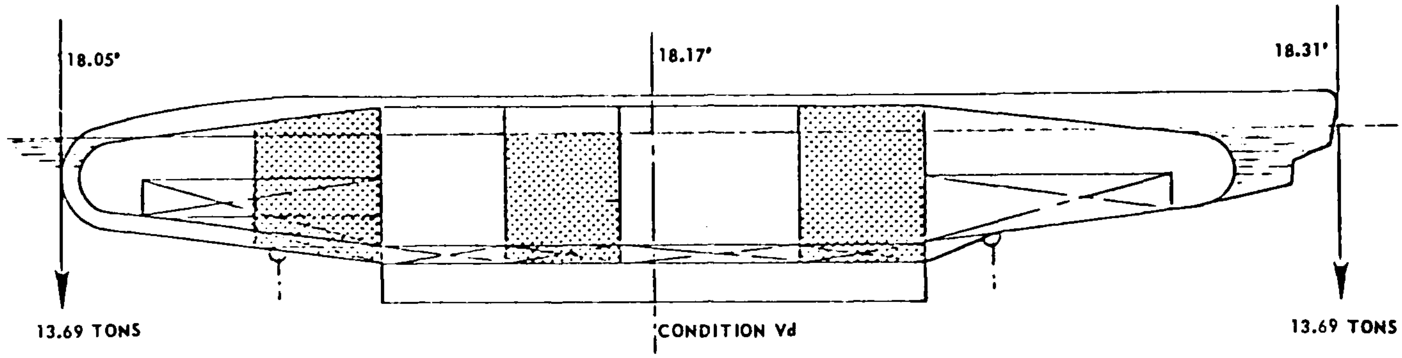
CONDITION IV - BOW & STERN MOORING LINES SLACK

a. BALLAST TANKS 1, 2, 3, 4, 9, & 10 PRESSED UP; TANKS 5, 6, 7, & 8 VOID

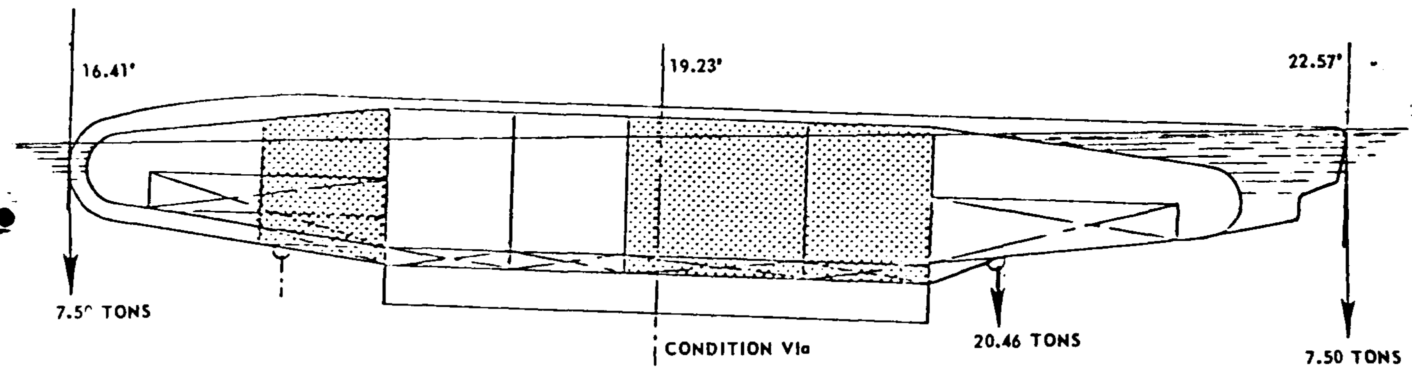
d. BALLAST TANKS 1, 2, 9, & 10 PRESSED UP; TANKS 3, 4, 7, & 8 VOID; 5 & 6 FREE FLOODING



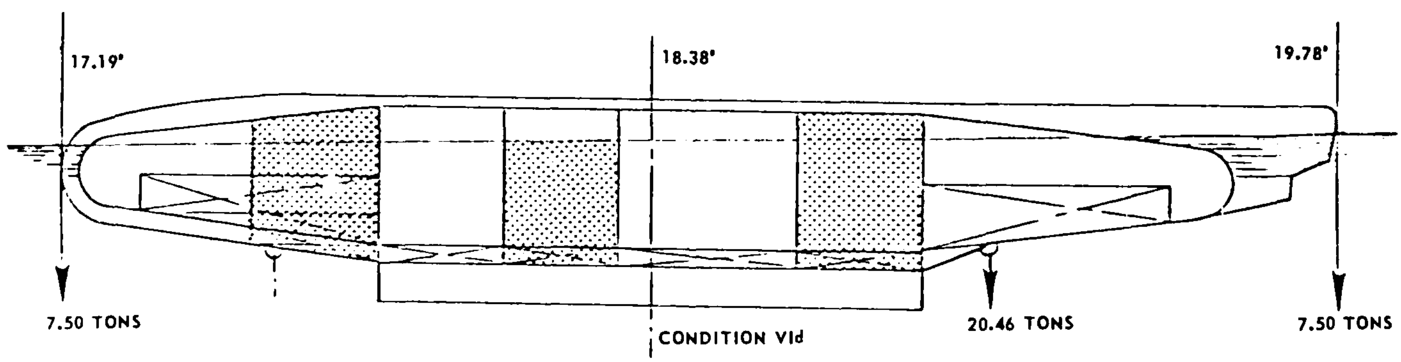
CONDITION Va



CONDITION Vd



CONDITION VIa



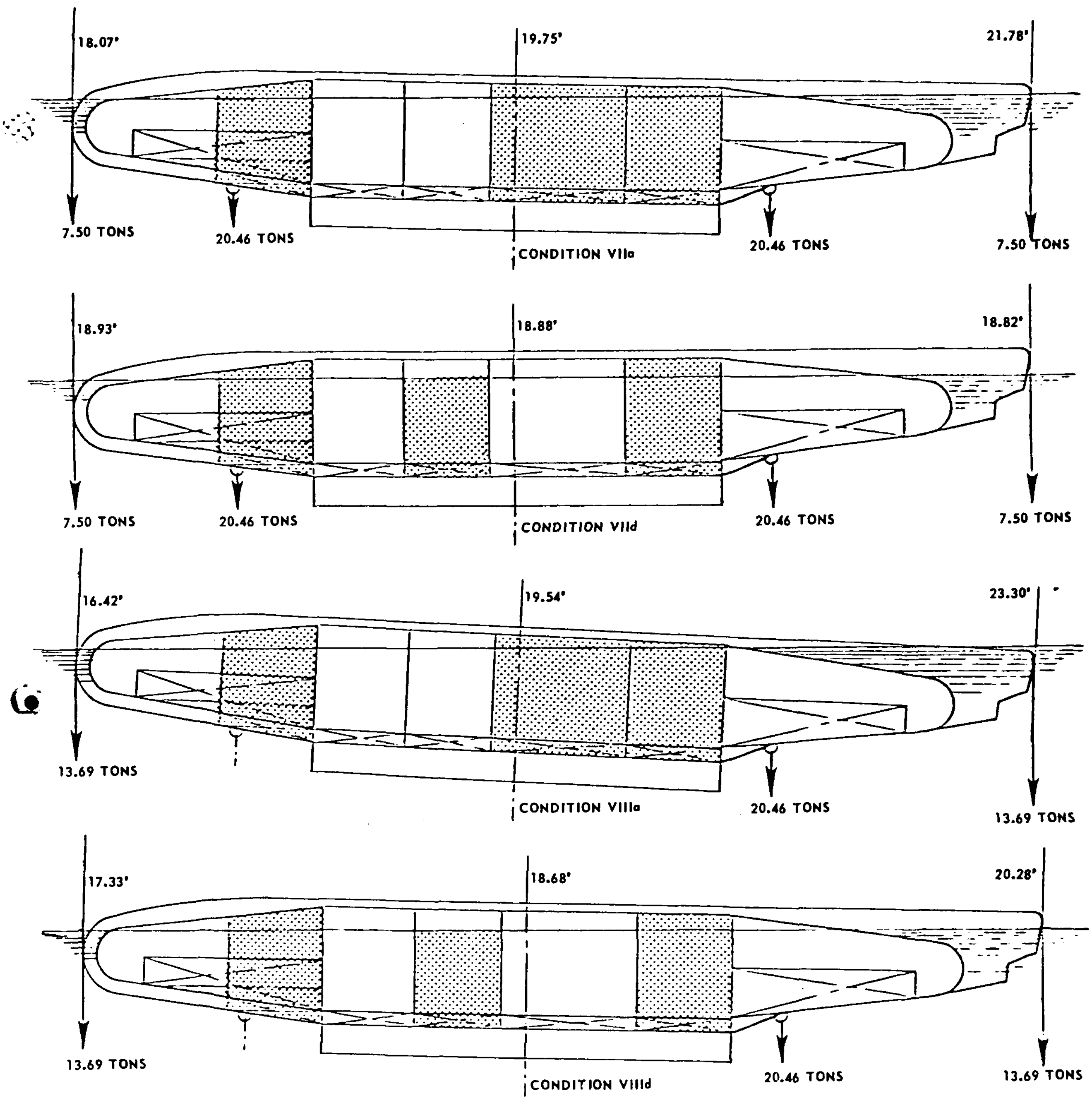
CONDITION VId

CONDITION V - BOW & STERN MOORING LINES TAUT

CONDITION VI - BOW & STERN MOORING LINES SLACK FORWARD ANCHOR LEG SUSPENDED

a. BALLAST TANKS 1, 2, 3, 4, 9, & 10 PRESSED UP; TANKS 5, 6, 7, & 8 VOID

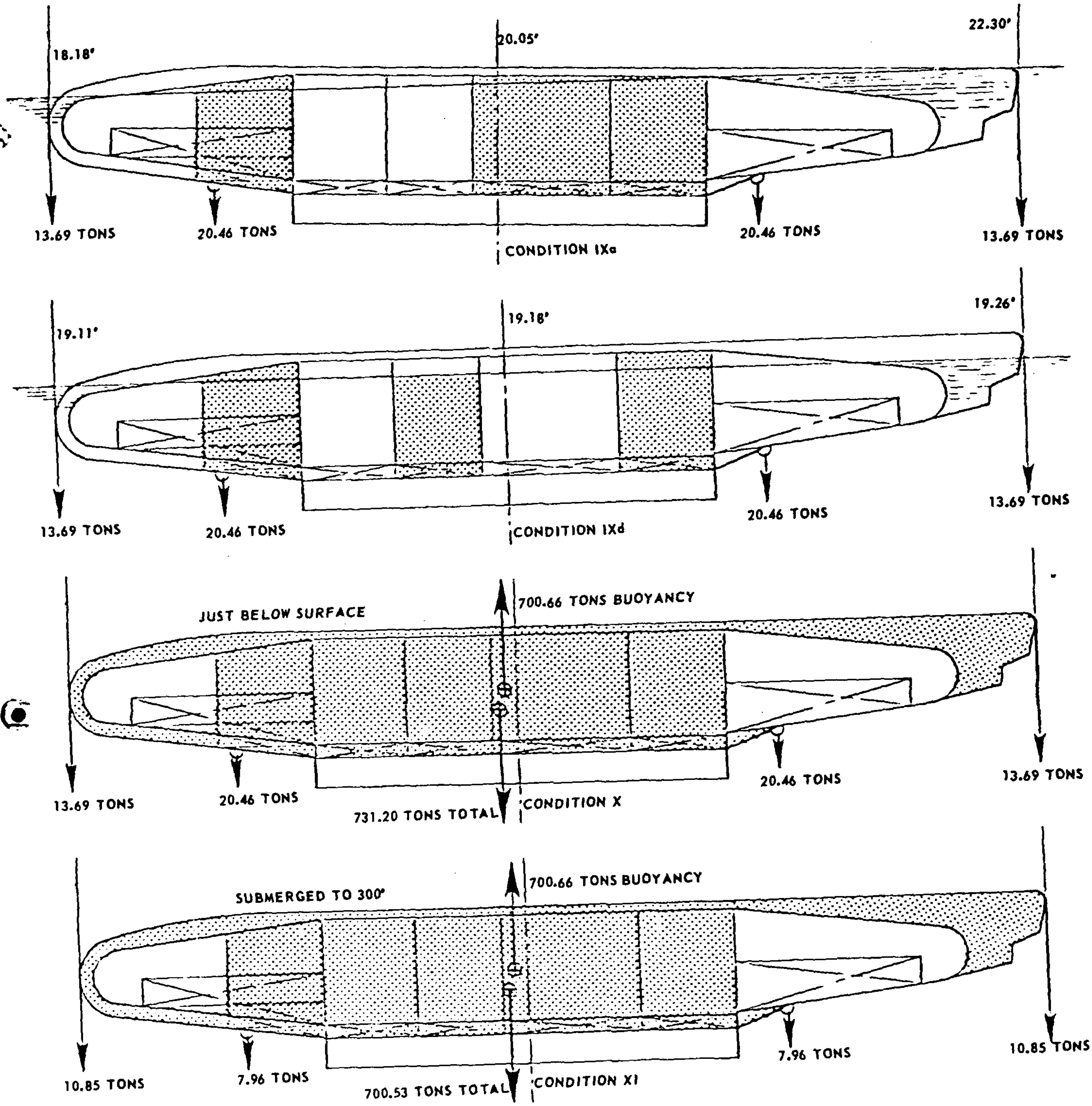
d. BALLAST TANKS 1, 2, 9, 10 PRESSED UP; TANKS 3, 4, 7, & 8 VOID; 5 & 6 FREE FLOODING



CONDITION VII - BOW & STERN MOORING LINES SLACK
FORWARD & AFTER ANCHOR LEGS
SUSPENDED

CONDITION VIII - BOW & STERN MOORING LINES TAUT
FORWARD ANCHOR LEG SUSPENDED

a. BALLAST TANKS 1, 2, 3, 4, 9, & 10 PRESSED UP; TANKS 5, 6, 7, & 8 VOID
d. BALLAST TANKS 1, 2, 9, 10 PRESSED UP; TANKS 3, 4, 7, & 8 VOID; 5 & 6 FREE FLOODING



CONDITION IX - BOW & STERN MOORING LINES TAUT
FORWARD & AFTER ANCHOR LEGS
SUSPENDED

CONDITION X - FULLY BALLASTED - SURFACE
CONDITION XI - FULLY BALLASTED - 300'

a. BALLAST TANKS , 2, 3, 4, 9, & 10 PRESSED UP; TANKS 5, 6, 7, & 8 VOID
d. BALLAST TANKS 1, 2, 9, & 10 PRESSED UP; TANKS 3, 4, 7, & 8 VOID; 5 & 6 FREE FLOODING

1. Remove all ballast water from the forward and after trim tanks. This will increase the final reserve buoyancy by 5.13 tons over the currently planned procedure.

2. Fill and press up Ballast Tanks 1, 2, 9, and 10 with *fresh* water. This will increase the final reserve buoyancy another 2.22 tons over the currently planned procedure.

3. Reduce the amount of chain in the upper mooring lines and relocate it to the bottom of the mooring lines. This too should increase the reserve buoyancy in the final condition.

4. Remove the cover plates from the bottom of Ballast Tanks 3 & 4 and test the vent, flood, and blow condition of these tanks.

5. Before leaving the pier for the mooring operation, blow Tanks 3, 4, 7, and 8 empty leaving Tanks 5 and 6 free flooded to the outside waterline.

APPENDIX C

ENVIRONMENTAL CHARACTERISTICS OF THE SITE

WIND

Average wind speeds vary little monthly between the 8.5 knot October minimum and the 10.2 knot maximum found during March and April. The predominant wind direction is consistently out of the Northwest with speeds of 10.7 knots to 12.7 knots. Gusty winds approaching 50 knots and gale force sustained winds of 34 knots can be expected every two years. Winds of this strength are most likely during the winter season. Only five percent of surface winds exceed 17 knots during August and October. Winds in the area are strongest between January and April; March is generally the most windy month but wind speeds are most likely to attain gale force during February. Most cyclones originate in the area during January, February, and April. Low pressure centers are most likely to pass through the area during the summer months (July-September).

PRECIPITATION

Precipitation is most frequent (about 5%) during the months of December, January, and February. The highest frequency of total precipitation occurs during the months of November through February when winds are blowing out of the Southeast to Southwesterly Quadrants. The mean number of days during which precipitation exceeds 0.1 inches are seven during December and four during March. December and March normally record the maximum total amounts of monthly precipitation of 4.23 inches and 1.69 inches respectively. Thunderstorms are most likely to be encountered during November (.7 day) and September (.3 day) respectively.

VISIBILITY

Between November and February visibility decreases below 1/2 mile between 1.6% and 4.1% of the time with maximum restriction during February. October shows 8% frequency of fog while July-October records show fog combined with haze on the order of 12% of the time. Visibility reduction to less than 1/2 mile is caused principally by radiation fog three to seven days per month between September and April. This fog is thickest during late night and early morning hours.

SURFACE CURRENTS

Mean current speeds are on the order of 0.5 knots. The prevailing current direction is from the Northwest and North from January to August and from the Southeast and East from September to December. At least 90% of the currents are less than 0.9 knots.

WAVE HEIGHTS

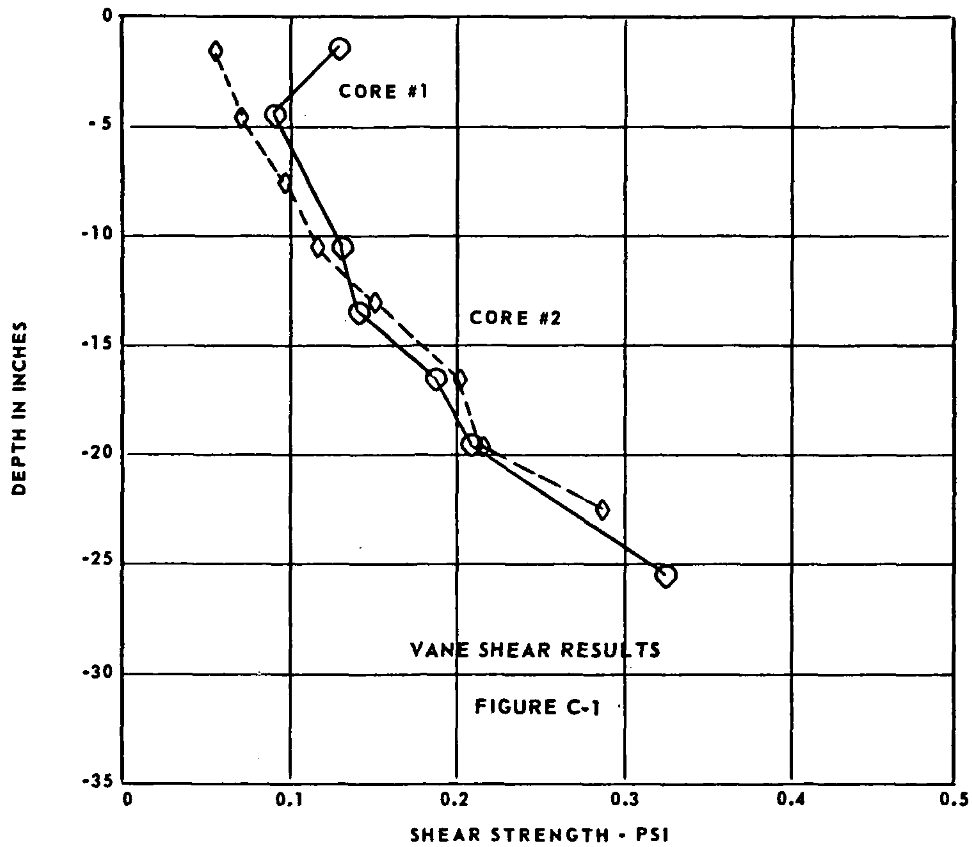
Calmest seas of 2 feet or less are most likely to be encountered during February. Seas greater than 2 feet high are most likely to be encountered during April. Seas greater than 6 feet high occur on the order of 15% of the time during April, November, and December. From August to October, seas greater than six feet are least likely to be encountered. Seas higher than nine feet are least likely during June and July and they are most likely during February. Highest seas are most likely to occur during the months of December, February, March, and April. Calmest conditions occur during the months of May, August, September, and October when 95% of the waves are six feet or less in height. Fifteen foot waves repeat on the order of every two years.

BATHYMETRY AND BOTTOM CHARACTERISTICS

According to an article written by Normark and Pipe which appeared in the March 1972 issue of the Journal of Geology, the proposed site for the *SQUAW* mooring (32° 2-' N Latitude; 117° 50' W Longitude) has a bottom depth of approximately 1860m (6102 ft.). The topography of the ocean floor in this area is characterized by gentle slopes and freedom from channels. Bottom sediments range in thickness from 300m to 400m and consist primarily of mud (comprising 80 - 90% clay) mixed in some places with thin sand. Some evidence suggests the existence of turbidity currents in the area which are capable of transporting large amounts of sediment, although the article gives no quantitative information as to the intensity of these currents.

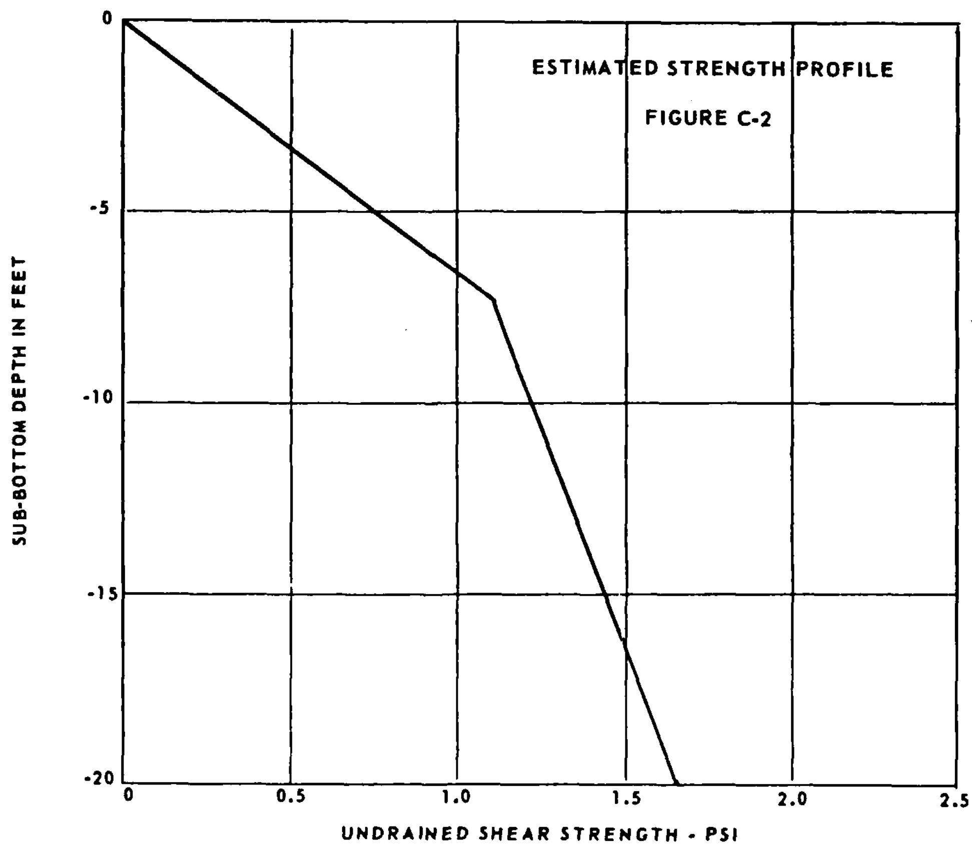
To obtain direct data on bathymetry and bottom characteristics, representatives of CHESNAVFACENGCOM boarded the *USS ABNAKI (ATF-96)* on 25 July 1977 to transit to the site for a bathymetric survey and to collect core samples for analysis. Several transits were made across the general area where the *SQUAW* is to be moored covering a period of about seven hours. During this time the fathometer readout showed a constant 1050 fathoms. Upon later analysis of the graphic depth readout from the fathometer it was concluded that an average value of 1040 fathoms, or 6240 feet should be used for the mooring design.

During the same period two bottom core samples were taken that were transferred to the Civil Engineering Laboratory for analysis. The vane shear test results are given in Figure C-1. Since the cores were so shallow, CEL utilized experience and data on other samples in the area to extrapolate the results to a greater sub-bottom depth; these results are given in Figure C-2.



VANE SHEAR RESULTS

FIGURE C-1



ESTIMATED STRENGTH PROFILE

FIGURE C-2

APPENDIX D

TASK ORDER P0004

CONTRACTS N00024-76-A-2035; N00024-78-PR-00195

CROWLEY MARITIME SALVAGE

ONE MARKET PLAZA

SAN FRANCISCO, CA 94105

STATEMENT OF WORK

STATEMENT OF WORK

The Contractor shall develop an operational plan and provide vessels, personnel and miscellaneous equipment to install the *SQUAW MOOR* off San Diego, California, 300 feet below the water in 6000 FSW. The moor will be oriented in a north-south direction on two mooring legs. There will be two additional legs suspended vertically from the sub for stabilization at the 300 ft. depth.

The *SQUAW* is a 135' long, 408 ton small submarine which will be used as a sonar training device. The *SQUAW* will be rigged with 4 chain pendants (one for each leg) and made ready for installation by the Government. Installation of the *SQUAW* and its mooring system will be undertaken by Crowley in accordance with plans approved by a designated Government representative or agency.

PLACE OF PERFORMANCE

These services shall be performed in the vicinity of Washington, D. C.; San Francisco, California; and San Diego, California.

COMPLETION DATE

The desired completion date, including submission of post operation reports, is 15 August 1978.

BASIS AND AMOUNT OF COMPENSATION

The work as outlined herein will be undertaken by Crowley under firm fixed price provisions of the Basic Ordering Agreement for an amount of $174,600.00.

GOVERNMENT FURNISHED EQUIPMENT AND MATERIALS

The Government will provide:

a. *SQUAW*, ready for installation with 4 chain pendants, Public Works Center, San Diego.

b. Bow leg and stern leg, each with:

- o anchor, 6000 lb. lwt.
- o chain, 2", 90' length
- o clump, 7000 lb. steel - air weight, water weight approximately 6000 lbs.

- o chain, 2", 100' length
- o wire rope, 1.25" dia., 8570' length
- o shackles and other hardware

c. Center legs (two) each with:

- o clump, steel and concrete, about 5' cubed, approximately 40,000 lbs. air weight (approximately 28,000 lb. water weight)
- o chain, 2", 25' length
- o swivel 33 ton rating
- o wire rope, 1.25" dia., 5470' length
- o chain, 2", 155' length
- o shackles and other hardware

d. Wire rope, 1.25" dia., 8570' spare length

e. Wire rope, 1 1/8" dia., approximately 12,000' length, lowering line

f. Anchor, 6000 lb., spare lwt or similar

g. Chain, 2", spare 3 to 4 shots

h. Shackles and other hardware, spare

i. Acoustic releases with support equipment

j. Tension monitoring equipment and operating personnel

With the exception of those items listed below, all Government furnished equipment and materials will be delivered to Crowley at a designated site in San Francisco Bay. The following items will be delivered to Crowley at a designated site in San Diego.

Squaw rigged and ready for installation
6000 lb. anchors (3)
7000 lb. steel clumps (2)
40,000 lb. steel and concrete clumps (2)

Any costs incurred by Crowley in procurement or transporting of those items identified as Government furnished will be charged to the Government in addition to the Fixed Price, and in accordance with terms of the Basic Ordering Agreement.

AVAILABLE PLANS AND TECHNICAL INFORMATION

The Government will provide, at no cost to Crowley, all plans and technical data related to the *SQUAW* and the mooring system, which may be available.

CROWLEY WILL PROVIDE

With the exception of those items identified as Government furnished, Crowley will provide all equipment, materials, and labor necessary to (1) prepare an operational plan for installation of the *SQUAW*, (2) execute the approved plan, (3) prepare a post operational report.

OPERATIONAL PLAN

The operational plan shall be developed by Crowley in sufficient detail to enable the designated Government representative or agency to insure that Crowley intends to install the *SQUAW* and associated moorings in an expedient, professional manner employing methods which minimize the potential for damage to the system during installation. The plan as approved in writing by the designated Government representative or agency will be considered a part of this Agreement.

ON-SITE MESSING AND BERTHING FACILITIES

On-site messing and berthing facilities will be available for Crowley personnel and a maximum of ten (10) Government representatives. Should the Government require additional on-site personnel, and should Crowley determine that additional facilities can be provided aboard the on-site vessel(s) such facilities will be provided at an additional cost to the Government.

FINAL *SQUAW* POSITION

Required final location for *SQUAW* and tolerances are as follows:

Latitude: 50 20' N (plus or minus .5 mile)
Longitude: 117 50' W (plus or minus .5 mile)
SQUAW depth: 300 ft. (plus or minus 50 feet)
Heading of *SQUAW:* North/South (only general North/South configuration required)

MOORING LEG TENSIONS

Maximum mooring leg tension as determined by measuring equipment provided and operated by the Government is 32,000 lbs. Tensions less than the maximum may

AD-A163 372 PROJECT EXECUTION PLAN FOR 1978 SQUAW MOORING(U) NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON DC CHESAPEAKE DIV SEP 78 CHES/NAVFAC-FPO-1-78(7) 2/2

UNCLASSIFIED F/G 13/10 NL

END

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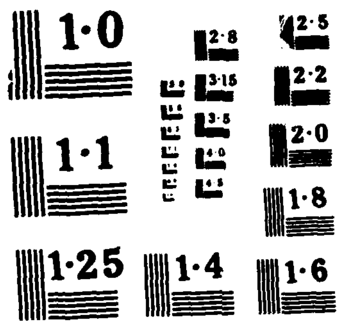

NATIONAL BUREAU OF STANDARDS
MICROCOPY RESOLUTION TEST CHART

be accepted by the Government's designated on-site representative.

WEATHER DELAYS OR DELAYS NOT THE FAULT OF CROWLEY

For each day or part thereof during which Crowley is prevented from working as a result of adverse weather or any other delay not the fault of Crowley, Crowley shall be compensated in the amount of $9,180. Such amount shall be paid in addition to other payments due Crowley under this Agreement.

A weather day for the purpose of this Agreement is defined as winds in excess of 25 knots or ocean well exceeding 6'.

For each day or part thereof during which Crowley is prevented from working as a result of adverse weather, delays caused by the Government or any other delay not the fault of Crowley, Crowley shall be compensated at a negotiated rate not to exceed $9,180.00. Such amount shall be paid in addition to other payments due Crowley under this Agreement.

SECURITY CLASSIFICATION

No Security Clearance is required for the performance of this task.

GENERAL PROVISIONS

General Provisions for this Task Order are those called out as applicable to Fixed Price Task Orders in Section L of the Basic Ordering Agreement.

DESIGNATED GOVERNMENT REPRESENTATIVE AND/OR AGENCY

The Government will provide Crowley in writing with the name of the Government representative or Agency to whom Crowley is responsible for matters related to the execution of work covered under this Agreement.

APPENDIX E

COMPUTATION OF MOORING TENSIONS FROM CATENARY EQUATIONS

MOOR CONFIGURATION

WATER DEPTH =	6215
CHAIN SIZE =	2.000
CHAIN BREAK STRENGTH =	322000
CHAIN WEIGHT =	3[illegible].430
WIRE ROPE DIAMETER =	1.250
WIRE ROPE BREAK STRENGTH =	158000
WIRE ROPE WEIGHT =	[illegible].204
CHAIN SCOPE OFF BOTTOM =	[illegible]4
CHAIN HEIGHT OFF BOTTOM =	6.650
TOTAL CHAIN LENGTH =	180
TOTAL WIRE ROPE LENGTH =	8570

SUBMERGED CONDITION

SUBMERGED DEPTH OF SQUAW = 300
HORIZONTAL FORCE AT SQUAW = 10000

	X	Y	ANGLE	T	F(V)
ANCHOR	0	0	0.	10000	0
CHAIN/BOTTOM	116	0	0.	10000	0
CHAIN/WIRE	180	7	11.79	10216	2088
SQUAW	5984	5915	64.51	23238	20976

SURFACE CONDITION
HORIZONTAL FORCE AT SQUAW = 16235

	X	Y	ANGLE	T	F(V)
ANCHOR	0	0	9.70	16470	2775
CHAIN/BOTTOM	0	0	9.70	16470	2775
CHAIN/WIRE	170	59	27.99	18386	8629
SQUAW	5982	6213	59.46	31949	27517

COMPONENT SAFETY FACTORS

SUBMERGED CONDITION

WIRE ROPE SAFETY FACTOR = 6.80
CHAIN SAFETY FACTOR = 31.52

SURFACE CONDITION

WIRE ROPE SAFETY FACTOR = 4.95
CHAIN SAFETY FACTOR = 17.51

[illegible]
[illegible]
[illegible] -25

EFFECT OF CHANGES IN LENGTH OF VERTICAL LEGS

SQUAW SUBMERGED CONDITION

CHANGE IN VERTICAL LEG LENGTH = -25.00
SQUAW HEIGHT ABOVE BOTTOM = 5890.00
CHAIN SCOPE = 180.50
[illegible] SCOPE = [illegible]

			ANCHOR			SQUAW					
X	Y	H	FHI	T	F(V)	FHI	T	F(V)	[illegible]	S.F.	C.H.
5785	5892	7710	0.	7710	0	68.13	20702	19212	0.	7.63	*0
5839	5892	8165	0.	8165	0	67.32	21174	195[illegible]7	8.53	7.46	*1
5885	5892	8610	0.	8610	0	66.56	21647	19861	9.62	7.30	2
5926	5891	9050	0.	9050	0	65.85	22121	20185	10.61	7.14	3
5963	5891	9485	0.	9485	0	65.18	22596	20509	11.69	6.99	4
5996	5891	9910	0.	9910	0	64.56	23071	20834	13.23	6.85	6
6024	5892	10330	0.	10330	0	63.98	23545	21158	14.57	6.71	8
6051	5891	10750	0.	10750	0	63.42	24022	21482	15.50	6.58	10
6076	5891	11165	0.	11165	0	62.89	24499	21807	17.06	6.45	12
6098	5891	11575	0.	11575	0	62.39	24975	22131	18.80	6.33	14
6118	5891	11985	0.	11985	0	61.91	25453	22455	19.87	6.21	16
6137	5891	12390	0.	12390	0	61.46	25931	22780	21.94	6.09	18
6154	5891	12795	0.	12795	0	61.02	26410	23104	23.11	5.98	21
6170	5892	13195	0.	13195	0	60.61	26888	23428	25.60	5.88	23
6186	5891	13600	0.	13600	0	60.21	27370	23752	25.50	5.77	26
6200	5891	14000	0.	14000	0	59.82	27851	24077	28.27	5.67	29
6212	5892	14395	0.	14395	0	59.46	28331	24401	31.49	5.58	31
6225	5891	14795	0.	14795	0	59.10	28814	24725	30.97	5.48	34
6226	5891	14815	0.	14815	0	59.09	28838	24742	31.72	5.48	34

?

[illegible] 5915.00
ENTER CHANGE IN VERTICAL LEG LENGTH
? 50

EFFECT OF CHANGES IN LENGTH OF VERTICAL LEGS

SQUAW SUBMERGED CONDITION

CHANGE IN VERTICAL LEG LENGTH = 50.00
SQUAW HEIGHT ABOVE BOTTOM = [illegible]
CHAIN SCOPE = 180.50
[illegible] SCOPE = [illegible]

			ANCHOR			SQUAW					
X	Y	H	FHI	T	F(V)	FHI	T	F(V)	[illegible]	S.F.	C.H.
5814	5866	7800	0.	7800	0	67.90	20735	19212	0.	7.62	*0
[illegible]	[illegible]	[illegible]	0.	[illegible]	0	[illegible]	[illegible]	19537	8.74	7.45	*1
5913	5866	8705	0.	8705	0	66.32	21685	19861	9.66	7.29	2
5953	5867	9145	0.	9145	0	65.63	22160	20185	10.91	7.13	3
5989	5866	9580	0.	9580	0	64.96	22637	20509	12.02	6.98	4
6022	5866	10010	0.	10010	0	64.34	23114	20834	13.23	6.84	6
6051	5866	10435	0.	10435	0	63.75	23591	21158	14.55	6.70	8
6077	5866	10855	0.	10855	0	63.19	[illegible]	21482	[illegible]	6.56	[illegible]
6101	5867	11270	0.	11270	0	62.67	24547	21807	17.65	6.44	[illegible]
6123	5866	11685	0.	11685	0	62.17	25026	22131	18.69	6.31	14
6143	5867	12095	0.	12095	0	61.69	25505	22455	20.62	6.19	16
6162	5867	12505	0.	12505	0	61.24	25986	22780	21.76	6.08	18
6179	5867	12910	0.	12910	0	60.80	26466	23104	24.06	5.97	21
6195	5867	13315	0.	13315	0	60.39	26947	23428	25.31	5.86	23
6210	5867	13720	0.	13720	0	59.99	27430	23752	26.60	5.76	26
6224	5866	14125	0.	14125	0	59.60	27914	24077	27.92	5.66	28
6237	5866	14525	0.	14525	0	59.24	28397	24401	31.02	5.56	31
6249	5866	14925	0.	14525	0	58.88	28881	24725	32.49	5.47	34
6250	5866	14945	0.	14945	0	58.87	28905	24742	33.27	5.47	34

?

ENTER DEPTH ERROR
? 0
? 0
DESIGN VERTICAL DISPLACEMENT OF SQUAW IS 5915.00
ENTER CHANGE IN VERTICAL LEG LENGTH
? 25

EFFECT OF CHANGES IN LENGTH OF VERTICAL LEGS

SQUAW SUBMERGED CONDITION

CHANGE IN VERTICAL LEG LENGTH = 25.00
SQUAW HEIGHT ABOVE BOTTOM = 5940.00
CHAIN SCOPE = 180.50
ROPE SCOPE = 8569.84

			ANCHOR			SQUAW					
X	Y	H	PHI	T	F(V)	PHI	T	F(V)	K	S.F.	C.H.
5728	5942	7535	0.	7535	0	68.58	20637	19212	0.	7.66	*0
5782	5942	7985	0.	7985	0	67.77	21105	19537	8.27	7.49	*1
5831	5941	8430	0.	8430	0	67.00	21576	19861	9.14	7.32	2
5871	5942	8860	0.	8860	0	66.30	22044	20185	10.56	7.17	3
5909	5941	9290	0.	9290	0	65.63	22515	20509	11.34	7.02	4
5942	5942	9710	0.	9710	0	65.01	22985	20834	12.83	6.87	6
5973	5941	10130	0.	10130	0	64.42	23458	21158	13.69	6.74	8
5999	5942	10540	0.	10540	0	63.87	23929	21482	15.59	6.60	10
6024	5942	10950	0.	10950	0	63.34	24401	21807	16.54	6.48	12
6046	5942	11355	0.	11355	0	62.84	24874	22131	18.22	6.35	14
6067	5942	11760	0.	11760	0	62.36	25348	22455	19.25	6.23	16
6086	5942	12160	0.	12160	0	61.91	25822	22780	21.26	6.12	19
6104	5942	12560	0.	12560	0	61.47	26297	23104	22.38	6.01	21
6121	5941	12960	0.	12960	0	61.05	26774	23428	23.54	5.90	24
6136	5941	13355	0.	13355	0	60.65	27249	23752	26.09	5.80	26
6150	5941	13750	0.	13750	0	60.27	27726	24077	27.36	5.70	29
6163	5942	14140	0.	14140	0	59.91	28202	24401	30.48	5.60	32
6176	5941	14535	0.	14535	0	59.55	28681	24725	29.96	5.51	35
6177	5941	14555	0.	14555	0	59.53	28705	24742	28.92	5.50	35

?

DESIGN VERTICAL DISPLACEMENT OF SQUAW IS [illegible]
ENTER CHANGE IN VERTICAL LEG LENGTH
? 50

EFFECT OF CHANGES IN LENGTH OF VERTICAL LEGS

SQUAW SUBMERGED CONDITION

CHANGE IN VERTICAL LEG LENGTH = 50.00
SQUAW HEIGHT ABOVE BOTTOM = [illegible]
CHAIN SCOPE = 180.50
ROPE SCOPE = [illegible]

			ANCHOR			SQUAW					
X	Y	H	PHI	T	F(V)	PHI	T	F(V)	K	S.F.	C.H.
5699	5966	7450	0.	7450	0	68.81	20606	19212	0.	7.67	*0
5755	5966	7900	0.	7900	0	67.98	21073	19537	8.08	7.50	*1
5801	5967	8335	0.	8335	0	67.23	21539	19861	9.31	7.34	2
5845	5966	8770	0.	8770	0	66.52	22008	20185	10.03	7.18	3
5882	5966	9195	0.	9195	0	65.85	22476	20509	11.33	7.03	4
5916	5966	9615	0.	9615	0	65.23	22945	20834	12.47	6.88	6
5946	5966	10030	0.	10030	0	64.64	23415	21158	13.71	[illegible]	8
5977	5966	10440	0.	10440	0	64.08	23885	21482	15.09	6.62	10
5998	5966	10845	0.	10845	0	63.56	24355	21807	16.62	6.49	12
6021	5966	11250	0.	11250	0	63.05	24826	22131	17.59	6.36	14
6041	5966	11650	0.	11650	0	62.58	25297	22455	19.40	6.25	16
6061	5966	12050	0.	12050	0	62.12	25770	22780	20.46	6.13	19
6078	5966	12445	0.	12445	0	61.69	26242	23104	22.62	6.02	21
6095	5966	12840	0.	12840	0	61.27	26716	23428	23.78	5.91	24
6111	5966	13235	0.	13235	0	60.87	27191	23752	24.98	5.81	27
6125	5966	13625	0.	13625	0	60.49	27665	24077	27.74	5.71	29
6138	5966	14015	0.	14015	0	60.13	28139	24401	29.06	5.61	32
6151	5966	14405	0.	14405	0	59.77	28615	24725	30.41	5.52	35
6152	5966	14425	0.	14425	0	59.76	28640	24742	27.66	5.52	35

?

EFFECT OF HORIZONTAL INACCURACIES

SQUAW SUBMERGED CONDITION

CHAIN SCOPE = 180.50
ROPE SCOPE = 8569.84

			ANCHOR			SQUAW					
X	Y	H	PHI	T	F(V)	PHI	T	F(V)	[illegible]	S.F.	C.H.
5757	5916	7625	0.	7625	0	68.35	20670	19212	0.	7.64	#0
5810	5917	8075	0.	8075	0	67.54	21140	19537	8.49	7.47	#1
5858	5916	8520	0.	8520	0	66.78	21611	19861	9.28	7.31	2
5899	5917	8955	0.	8955	0	66.08	22082	20185	10.58	7.16	3
5936	5917	9385	0.	9385	0	65.41	22555	20509	11.66	7.01	4
5969	5916	9810	0.	9810	0	64.79	23028	20834	12.83	6.86	6
5999	5916	10230	0.	10230	0	64.20	23501	21158	14.12	6.72	8
6025	5916	10645	0.	10645	0	63.64	23975	21482	15.54	6.59	10
6049	5917	11055	0.	11055	0	63.12	24449	21807	17.12	6.46	12
6072	5917	11465	0.	11465	0	62.61	24924	22131	18.12	6.34	14
6092	5917	11870	0.	11870	0	62.14	25399	22455	19.99	6.22	16
6111	5917	12275	0.	12275	0	61.68	25876	22780	21.08	6.11	19
6129	5917	12675	0.	12675	0	61.25	26352	23104	23.31	6.00	21
6145	5917	13075	0.	13075	0	60.83	26830	23428	24.52	5.89	24
6160	5917	13475	0.	13475	0	60.43	27308	23752	25.75	5.79	26
6175	5916	13875	0.	13875	0	60.05	27789	24077	27.02	5.69	29
6188	5916	14270	0.	14270	0	59.68	28267	24401	30.03	5.59	32
6201	5916	14665	0.	14665	0	59.33	28747	24725	31.44	5.50	35
6202	5916	14685	0.	14685	0	59.31	28771	24742	30.27	5.49	35

?

EFFECT OF HORIZONTAL INACCURACIES

SQUAW SURFACE CONDITION

CHAIN SCOPE = 180.50
ROPE SCOPE = 8569.84

			ANCHOR			SQUAW					
X	Y	H	PHI	T	F(V)	PHI	T	F(V)	[illegible]	S.F.	C.H.
5895	6215	13175	0.	13175	0	61.96	28031	24742	0.	5.64	38
5904	6216	13425	1.00	13432	235	61.72	28[illegible]	24576	29.34	5.57	40
5912	6216	13705	2.00	13713	479	61.48	28703	25220	30.64	5.50	43
5922	6216	13990	3.00	14009	733	61.22	29063	25475	29.67	5.44	45
5931	6215	14285	4.00	14320	999	60.97	29439	25740	32.05	5.37	47
5939	6216	14585	5.00	14641	1276	60.73	29827	26018	38.66	5.30	49
5948	6216	14905	6.00	14987	1567	60.47	30237	26308	35.79	5.23	51
5957	6216	15240	7.00	15354	1871	60.20	30668	26613	37.40	5.15	53
5965	6216	15585	8.00	15738	2190	59.94	31116	26932	43.39	5.08	56
5972	6217	15945	9.00	16144	2525	59.68	31587	27267	47.17	5.00	58
5981	6216	16330	10.00	16582	2879	59.41	32087	27621	44.6[illegible]	4.92	60
5989	6217	16725	11.00	17038	3251	59.14	32608	27993	[illegible]	4.85	62
5997	6216	17155	1200	17538	3646	58.86	33169	28388	49.63	4.76	64
6005	6216	17600	13.00	18063	4063	58.57	33756	28805	58.12	4.68	66
6012	6216	18070	14.00	18623	4505	58.29	34379	29247	62.81	4.60	68
6019	6216	18565	15.00	19220	4974	58.01	35039	29716	70.[illegible]7	4.51	70
6027	6216	19095	16.00	19865	5475	57.71	35745	30217	71.60	4.42	72
6033	6217	19655	17.00	20553	6009	57.41	36496	30751	82.04	4.33	74
6041	6216	20260	18.00	21303	6583	57.11	37305	31324	81.12	4.24	76
6047	6217	20895	19.00	22099	7195	56.80	38164	31936	103.86	4.14	78
6054	6217	21590	20.00	22976	7858	56.48	39101	32600	96.20	4.04	80
6061	6217	22330	21.00	23919	8572	56.17	40105	33313	116.46	3.94	82
6067	6217	23135	22.00	24952	9347	55.84	41198	34089	120.98	3.84	84
6074	6216	24010	23.00	26084	10192	55.50	42389	34933	131.79	3.73	86
6080	6217	24950	24.00	27311	11108	55.16	43678	35850	168.25	3.62	88
6086	6217	25990	25.00	28677	12119	54.81	45102	36861	167.27	3.50	90
6092	6217	27130	26.00	30185	13232	54.46	46669	37974	194.45	3.39	92
6097	6217	28390	27.00	31863	14465	54.09	48406	39207	220.62	3.26	94
6103	6217	29790	28.00	33739	15840	53.72	50342	40581	254.11	3.14	96
6108	6217	31350	29.00	35844	17378	53.34	52506	42119	309.25	3.01	98
6113	6217	33120	30.00	38244	19122	52.94	54963	43863	330.91	2.87	100

?

EFFECT OF [illegible]

ROUGH SURFACE CONDITION

ACTUAL WATER DEPTH [illegible]
CHAIN SLOPE [illegible]
PIPE SLOPE [illegible]

X	Y	B	PHI	T	F(X)	PHI	T	F(Y)	[illegible]	S.E.	[illegible]
5948	6165	13420	0.	13420	0	61.52	26147	24742	0.	5.61	38
5957	6166	13690	1.00	13692	239	61.28	26486	24980	29.41	5.55	40
5965	6167	13965	2.00	13974	488	61.03	26836	25229	34.30	5.48	42
5975	6166	14260	3.00	14280	747	60.77	29207	25489	30.40	5.41	44
5983	6167	14560	4.00	14596	1018	60.52	29590	25760	36.28	5.34	46
5992	6166	14880	5.00	14937	1302	60.26	29995	26043	33.72	5.27	49
6002	6165	15215	6.00	15299	1599	59.99	30419	26341	35.14	5.19	51
6009	6167	15550	7.00	15667	1909	59.74	30856	26651	48.52	5.12	53
6019	6166	15920	8.00	16076	2237	59.46	31326	26979	37.36	5.04	55
6026	6167	16290	9.00	16493	2580	59.20	31809	27322	52.73	4.97	57
6034	6167	16685	10.00	16942	2942	58.92	32323	27684	50.12	4.89	59
6042	6167	17105	11.00	17425	3325	58.64	32868	28066	50.04	4.81	61
6050	6166	17550	12.00	17942	3730	58.35	33446	28472	51.93	4.72	63
6058	6166	18010	13.00	18484	4158	58.07	34052	28899	64.04	4.64	65
6066	6166	18505	14.00	19072	4614	57.77	34701	29355	61.49	4.55	67
6073	6166	19025	15.00	19696	5098	57.48	35388	29839	70.92	4.46	70
6079	6167	19570	16.00	20359	5612	57.19	36115	30353	85.71	4.37	72
6087	6166	20165	17.00	21086	6165	56.88	36903	30907	76.92	4.28	74
6094	6166	20795	18.00	21865	6757	56.57	37743	31498	89.93	4.19	76
6101	6167	21465	19.00	22702	7391	56.26	38643	32133	104.73	4.09	78
6108	6166	22195	20.00	23619	8078	55.93	39620	32820	102.45	3.99	80
6114	6167	22975	21.00	24610	8819	55.61	40672	33561	122.44	3.88	82
6121	6166	23825	22.00	25696	9626	55.27	41818	34367	127.47	3.78	84
6127	6167	24740	23.00	26877	10502	54.93	43060	35243	155.13	3.67	86
6133	6167	25745	24.00	28181	11462	54.58	44424	36204	162.27	3.56	88
6139	6167	26845	25.00	29620	12518	54.23	45923	37260	185.65	3.44	90
6144	6167	28055	26.00	31214	13683	53.87	47577	38425	214.09	3.32	92
6150	6167	29395	27.00	32991	14978	53.50	49413	39719	245.54	3.20	94
6155	6167	30895	28.00	34991	16427	53.11	51472	41169	269.15	3.07	96
6161	6167	32575	29.00	37245	18057	52.72	53785	42798	322.08	2.94	98
6165	6167	34470	30.00	39803	19901	52.33	56402	44643	393.52	2.80	99

EFFECT OF DEPTH [illegible]

ROUGH SURFACE CONDITION

ACTUAL WATER DEPTH [illegible]
CHAIN SLOPE [illegible]
PIPE SLOPE [illegible]

X	Y	B	PHI	T	F(X)	PHI	T	F(Y)	[illegible]	S.E.	[illegible]
[illegible]	6191	13295	0.	13295	0	61.75	[illegible]	24742	0.	[illegible]	38
[illegible]	6190	[illegible]	1.00	[illegible]	237	61.49	26424	24978	[illegible]	[illegible]	40
5940	6190	[illegible]	2.00	13848	483	61.[illegible]	[illegible]	25225	30.90	5.49	42
[illegible]	6191	[illegible]	3.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5.42	45
[illegible]	6191	[illegible]	4.00	14460	[illegible]	[illegible]	29515	[illegible]	32.59	[illegible]	47
[illegible]	6191	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	35.55	5.28	49
5974	6191	[illegible]	6.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	40.79	5.21	51
5984	6190	[illegible]	7.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	35.71	5.14	53
5991	619.	15741	8.00	15900	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	5.0[illegible]	55
[illegible]	[illegible]	[illegible]	9.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4.98	57
6008	6191	[illegible]	10.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	43.94	4.91	59
[illegible]	6191	[illegible]	11.00	17237	3285	[illegible]	[illegible]	[illegible]	[illegible]	4.97	62
6024	6191	[illegible]	12.00	17738	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4.74	64
6031	6191	[illegible]	13.00	[illegible]	4111	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	66
6039	6191	[illegible]	14.00	18845	4559	58.03	[illegible]	29301	64.25	4.57	68
6044	[illegible]	[illegible]	15.00	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	73.12	4.49	70
6054	6191	[illegible]	16.00	20114	5544	[illegible]	35931	30286	70.41	4.40	72
6060	6192	[illegible]	17.00	20814	[illegible]	57.15	[illegible]	30827	87.60	4.31	74
6065	6191	[illegible]	18.00	21591	[illegible]	[illegible]	[illegible]	31411	92.51	4.21	[illegible]
6074	6192	[illegible]	19.00	22400	7253	56.57	38403	32074	[illegible]	4.11	[illegible]
6081	6192	21665	20.00	23390	[illegible]	[illegible]	39304	[illegible]	[illegible]	4.01	80
6087	6192	22650	21.00	24261	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3.91	82
6094	6191	23480	22.00	[illegible]	[illegible]	55.55	41567	[illegible]	[illegible]	[illegible]	84
6100	6192	24370	23.00	26475	10344	[illegible]	[illegible]	35066	[illegible]	3.70	[illegible]
6106	6192	25345	24.00	27744	11284	54.67	44045	[illegible]	159.70	3.59	88
6112	6192	26410	25.00	29140	[illegible]	[illegible]	45505	37057	164.05	3.47	90
6118	6192	[illegible]	26.00	[illegible]	13454	54.16	47115	38196	[illegible]	3.35	92
6124	6192	[illegible]	27.00	[illegible]	14718	[illegible]	[illegible]	39459	230.47	3.23	94
6129	6192	[illegible]	28.00	[illegible]	[illegible]	53.42	50898	40871	258.99	3.10	96
6134	6192	[illegible]	29.00	[illegible]	17713	53.03	[illegible]	42454	312.09	2.97	98
6139	6192	33785	30.00	[illegible]	19506	52.64	55671	44247	363.25	2.64	100

EFFECT OF [illegible]

[illegible] SURFACE CONDITION

5884	[illegible]	[illegible]	.00	13105	0	[illegible]	24067	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	13280	1.00	[illegible]	[illegible]	61.61	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5902	6226	13655	[illegible]	[illegible]	477	61.57	[illegible]	25.18	29.44	5.11	[illegible]
[illegible]	6227	[illegible]	[illegible]	[illegible]	736	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5920	6226	14225	4.00	[illegible]	995	61.07	[illegible]	25736	[illegible]	5.37	[illegible]
5928	6227	[illegible]	5.00	14590	1271	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5937	6226	14845	6.00	[illegible]	1560	[illegible]	30042	26302	[illegible]	[illegible]	[illegible]
5945	[illegible]	[illegible]	7.00	15214	1947	60.71	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5953	6227	[illegible]	8.00	15667	2180	[illegible]	[illegible]	26822	41.00	[illegible]	[illegible]
[illegible]	6227	[illegible]	[illegible]	16073	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5971	6226	[illegible]	10.00	16511	[illegible]	[illegible]	[illegible]	27609	[illegible]	4.93	60
5978	[illegible]	[illegible]	11.00	16967	[illegible]	[illegible]	[illegible]	27979	[illegible]	[illegible]	[illegible]
5986	6226	[illegible]	12.00	17456	3629	[illegible]	33117	[illegible]	[illegible]	[illegible]	64
5993	6227	17510	13.00	17971	4043	[illegible]	[illegible]	[illegible]	[illegible]	4.69	[illegible]
6001	6227	17980	14.00	18530	4483	58.40	34313	29224	[illegible]	[illegible]	68
[illegible]	[illegible]	18475	15.00	19122	4950	[illegible]	[illegible]	[illegible]	[illegible]	4.52	[illegible]
6015	6227	18995	16.00	19760	5447	57.82	35657	30188	72.43	4.43	72
6023	6227	19555	17.00	20449	5979	57.52	36416	30720	75.53	4.34	74
6030	6227	20150	18.00	21187	6547	57.22	37216	31289	84.75	4.25	76
6037	6226	20790	19.00	21988	7159	56.91	38027	31900	88.64	4.15	78
6043	6227	21470	20.00	22848	7814	56.60	38998	32556	105.31	4.05	80
6050	[illegible]	[illegible]	21.00	23780	8526	56.27	40060	33267	105.46	3.95	82
6057	6227	23000	22.00	24806	9293	55.95	41077	34034	129.30	3.85	84
6063	6226	23965	23.00	25926	10130	55.61	42256	34872	170.71	3.74	86
6069	6227	24795	24.00	27142	11039	55.28	43532	35781	164.69	3.63	88
6075	6227	25820	25.00	28489	12040	54.93	44940	36782	169.41	3.52	90
6081	6227	26945	26.00	29979	13142	54.58	46489	37883	193.10	3.40	92
6087	[illegible]	28195	27.00	31644	14366	54.21	48212	39108	205.84	3.28	94
6092	6227	29570	28.00	33490	15723	53.84	50117	40464	264.54	3.15	96
6097	6227	31115	29.00	35575	17247	53.46	52261	41989	284.95	3.02	98
6102	6227	32850	30.00	37932	18966	53.07	54676	43707	347.91	2.89	100

EFFECT OF DEPTH [illegible]

SQUAR SURFACE CONDITION

5867	6241	[illegible]	.00	[illegible]	0	61.19	[illegible]	24742	[illegible]	5.65	[illegible]
[illegible]	6240	13316	[illegible]	13312	172	61.94	[illegible]	24974	29.61	[illegible]	41
5885	6242	13570	[illegible]	[illegible]	414	61.71	28635	[illegible]	34.01	[illegible]	43
[illegible]	6240	[illegible]	3.00	13874	[illegible]	[illegible]	29292	[illegible]	26.94	5.45	45
[illegible]	6241	14140	4.00	14175	[illegible]	61.21	29360	[illegible]	34.61	[illegible]	47
5912	6241	14440	5.00	14495	1267	60.96	29745	26005	34.26	5.31	49
[illegible]	6242	[illegible]	6.00	14831	1550	[illegible]	30147	[illegible]	38.02	5.24	52
[illegible]	[illegible]	[illegible]	7.00	15188	1851	[illegible]	[illegible]	[illegible]	[illegible]	5.17	54
[illegible]	6241	[illegible]	8.00	[illegible]	[illegible]	[illegible]	31014	[illegible]	[illegible]	[illegible]	56
[illegible]	6241	[illegible]	[illegible]	15977	2499	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	6241	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	60
[illegible]	6241	[illegible]	[illegible]	[illegible]	3216	[illegible]	[illegible]	[illegible]	47.86	4.86	[illegible]
[illegible]	6242	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	64
[illegible]	6242	[illegible]	13.00	17647	4015	[illegible]	[illegible]	[illegible]	[illegible]	4.70	66
[illegible]	6241	[illegible]	[illegible]	[illegible]	4451	[illegible]	[illegible]	29192	[illegible]	[illegible]	68
[illegible]	6241	[illegible]	15.00	[illegible]	4916	[illegible]	34872	[illegible]	[illegible]	[illegible]	70
[illegible]	6241	[illegible]	[illegible]	19615	[illegible]	[illegible]	35559	30148	[illegible]	4.44	72
6007	6241	19410	17.00	20297	5934	[illegible]	36301	[illegible]	[illegible]	4.35	74
6013	6242	19990	18.00	21019	6495	57.38	37085	31237	91.81	4.26	76
6020	6242	[illegible]	19.00	[illegible]	7100	57.07	37935	31842	87.67	4.17	78
[illegible]	6242	[illegible]	20.00	[illegible]	7749	56.76	38844	[illegible]	[illegible]	[illegible]	80
6034	6241	22020	21.00	23567	8453	56.44	39834	33194	101.94	3.97	82
6040	6242	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	33953	[illegible]	[illegible]	84
6047	6241	[illegible]	23.00	25692	10039	[illegible]	[illegible]	34780	129.51	3.76	86
[illegible]	6242	[illegible]	24.00	[illegible]	[illegible]	[illegible]	43317	[illegible]	160.04	[illegible]	88
6059	6242	[illegible]	25.00	28213	11923	55.11	[illegible]	36665	[illegible]	3.53	90
6065	6242	[illegible]	26.00	[illegible]	13010	54.76	[illegible]	[illegible]	167.79	3.42	92
[illegible]	6242	[illegible]	27.00	31313	14216	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	94
6076	6242	[illegible]	28.00	33128	[illegible]	[illegible]	49751	40054	[illegible]	3.17	96
6081	6241	30760	29.00	35170	17051	[illegible]	51892	[illegible]	[illegible]	[illegible]	98
6067	6242	[illegible]	30.00	37487	16744	53.26	[illegible]	43485	[illegible]	2.91	100

EFFECT OF DEPTH INACCURACIES

SURFACE CONDITION

ACTUAL WATER DEPTH

5839	6266	12925	0.	12925	0	62.42	27514	24742	0.	[illegible]	[illegible]
5852	6265	13185	1.00	13187	230	62.17	28229	24972	24.[illegible]	[illegible]	
5859	6266	13445	2.00	13453	470	61.93	28572	25211	30.47	[illegible]	43
5868	6265	13720	3.00	13739	719	61.69	28922	25461	29.64	[illegible]	45
5875	6267	13995	4.00	14029	979	61.45	29281	25720	38.04	5.40	46
5885	6266	14295	5.00	14350	1251	61.19	29664	25992	30.71	5.33	[illegible]
5894	6266	14605	6.00	14685	1535	60.93	30063	26277	33.89	5.26	52
5903	6266	14925	7.00	15037	1833	60.61	30408	26574	35.67	5.19	54
5911	6266	15260	8.00	15410	2145	60.42	30911	26886	39.52	5.11	56
5918	6266	15605	9.00	15900	2472	60.17	31370	27213	46.67	5.04	58
5927	6266	15975	10.00	16221	2817	59.90	31854	27558	43.18	4.96	60
5935	6266	16360	11.00	16666	3180	59.63	32361	27922	48.67	4.95	62
5942	6267	16760	12.00	17134	3562	59.37	32934	28304	54.48	4.80	64
5951	6266	17195	13.00	17647	3970	59.09	33467	28711	49.37	4.72	66
5958	6267	17640	14.00	18180	4398	58.81	34063	29140	65.57	4.64	69
5965	6266	18120	15.00	18759	4855	58.52	34703	29597	61.43	4.55	71
5973	6266	18625	16.00	19376	5341	58.24	35361	30082	70.70	4.47	73
5979	6267	19160	17.00	20035	5858	57.95	36103	30595	77.95	4.39	75
5986	6267	19730	18.00	20745	6411	57.65	36875	31152	84.75	4.28	77
5994	6266	20350	19.00	21523	7007	57.34	37711	31749	82.61	4.19	79
6000	6266	21005	20.00	22353	7645	57.03	38602	32387	98.81	4.09	81
6007	6266	21710	21.00	23255	8334	56.72	39564	33025	107.30	3.99	83
6013	6267	22465	22.00	24229	9076	56.40	40600	33818	116.27	3.89	85
6020	6267	23295	23.00	25307	9898	56.07	41736	34630	121.29	3.79	87
6026	6267	24185	24.00	26474	10768	55.74	42963	35509	153.49	3.68	89
6032	6267	25165	25.00	27767	11735	55.40	44315	36476	156.88	3.57	91
6038	6267	26240	26.00	29195	12798	55.05	45801	37540	176.13	3.45	92
6043	6267	27415	27.00	30769	13969	54.69	47435	38710	215.81	3.33	94
6049	6267	28725	28.00	32533	15273	54.33	49256	40015	232.79	3.21	96
6054	6267	30195	29.00	34512	16732	53.95	51295	41473	220.36	3.08	98
6060	6267	31830	30.00	36754	18377	53.57	53594	43119	302.13	2.95	100

APPENDIX F

SPECIFICATIONS FOR WIRE ROPE ASSEMBLIES FOR THE SQUAW MOORING

SECTION 1

GENERAL PARAGRAPHS

1. GENERAL INTENTION: It is the declared and acknowledged intention and meaning to procure a set of wire rope assemblies complete with fittings ready for use.

2. GENERAL DESCRIPTION: The work includes fabricating, testing, packaging, and delivery, FOB contractor's plant, of the specified wire rope assemblies.

3. DELIVERY: The wire rope assemblies specified shall be delivered on-site addressed as follows:

Public Works Center
Material Division
Bldg 307
Naval Station
San Diego, California 92136

Mark for: Job Order 1246305
Squaw Mooring

Identification marking in addition to address marking, shall be as specified under paragraph 5.2 of Section 2.

4. FORM OF CONTRACT: The contract will be executed on Standard Form 33, November 1969 edition, and shall include the General Provisions (Supply Contract), dated June 1977.

5. COMMENCEMENT AND COMPLETION OF WORK: The Contractor shall commence work immediately after the date of receipt by him of contract and shall complete the entire work, including delivery, within 90 calendar days after the date of receipt of the contract.

6. ADDITIONAL DEFINITIONS: Whenever in the specifications words "directed," "required," "ordered," "designated," "prescribed," or words of like import are used, it shall be understood that the "direction," "requirement," "order," "designation," or "prescription," of the Contracting Officer is intended and similary the words "approved," "acceptable," "satisfactory," or words of like import shall mean "approved by," or "acceptable to," or "satisfactory to," the Contracting Officer, unless otherwise expressly stated.

7. REQUIREMENTS THAT THE BIDDER BE A UNITED STATES OR CANADIAN FIRM: Bids will be accepted only from firms which are incorporated or otherwise organized under the laws of a state of the United States or a U. S. Territory or possession, or of Canada; and having its principal office in the United States or a Territory or Possession thereof, or in Canada.

8. SPECIFICATIONS AND STANDARDS: The specifications and standards referenced in this specification, including addenda, amendments, and errata listed, shall govern in all cases where references thereto are made. In case of differences between these specifications or standards and this specification, this specification shall govern to the extent of such differences; otherwise, the referenced specifications and standards shall apply. The requirement for packaging, packing, marking, and preparation for shipment or delivery included in the referenced specifications shall apply only to materials and equipment that are furnished directly to the Government and not to materials and equipment that are to be furnished and installed by the Contractor.

8.1 When a number in parentheses is suffixed to a NAVFAC, NAVDOCKS Military or Federal Specification, it denotes the effective amendment or change to the document.

8.2 Unless otherwise specified by this contract specification, all tests required by the referenced specifications and standards shall be conducted at no expense to the Government under the supervision of and in a laboratory acceptable to the Government.

9. AVAILABILITY OF SPECIFICATIONS, STANDARDS, AND DESCRIPTIONS: Specifications, standards and data item descriptions cited in this solicitation are available as follows:

(a) Unclassified Federal and Military Specifications and Standards, and Data Item Descriptions: Submit request on DD From 1425 (Specifications and Standards Requisition) to:

Commanding Officer
U. S. Naval Publications and Forms Center
5801 Tabor Avenue
Philadelphia, PA 19120

The Department of Defense Index of Data Item Descriptions (TD-3) may be ordered on the DD Form 1425. The Department of Defense index of Specifications and Standards (DODISS) may be purchased from the Superintendent of Documents, U. S. Government Printing Office, Washington, DC 20402. When requesting a specification or standard, the request shall indicate the title, number, date, and any applicable amendment thereto by number and date. When requesting a data item description, the request shall cite the applicable data item set forth in the solicitation. When DD Form 1425 is not available, the request may be submitted in letter form, giving the same information as listed above, and the solicitation or contract number involved. Such a request may also be made to the activity by telegram or telephone (Area Code 215/697-3321) in case of urgency.

(b) Commerical Specifications, Standards, and Descriptions: These specifications, standards, and descriptions are not available from Government sources. They may be obtained from the publishers.

(c) Availability of Specification and Standards Not Listed in DODISS, Data Item Descriptions Not Listed in TD-3 and Plans, Drawings, and other Pertinent Documents: The specifications, standards, plans, drawings, descriptions, and other pertinent documents cited in this solicitation may be examined at the office where bids are submitted.

10. *DATA REQUIRED OF THE CONTRACTOR: Contract Data Requirements* Lists, DD Form 1423 to Contract N62477-78-C-0001, 1 page, and the following Data Item Descriptions, DD Form 1664, are attached at the end of this specification and are a part thereof. Data Item Descriptions shall not be used for any purpose other than that contemplated by this specification.

DATA ITEM DESCRIPTION	NUMBER
Schedule of Prices	UDI-F-24027
Program, Test	UDI-A-24033
Test Reports	DI-T-2072

11. CONTRACTOR'S TECHNICAL DATA CERTIFICATION: The bidder shall submit with his bid a certification as to whether he has delivered or is obligated to deliver to the Government under any other contract or subcontract the same or substantially the same technical data included in his offer; if so, he shall identify one such contract or subcontract under which such technical data was delivered or will be delivered, and the place or such delivery.

12. FACTORY INSPECTION: See Clause 5 of the General Provisions.

13. CONTRACTOR'S INVOICES: Requests for progress payments shall be submitted in triplicate on DD Form 1195.

SECTION 2

REQUIREMENTS

1. APPLICABLE PUBLICATIONS: The following publications of the issues listed below, but referred to thereafter by basic designation only, from a part of this specification to the extent specified and indicated.

1.1 Military Standards:

MIL-STD-129F & Change 1	Marking for Shipment and Storage

2. GENERAL: The wire rope assemblies specified are intended to be used in the mooring of a submarine hull in 6240 feet of water. Certain assemblies will be used as mooring lines while others will be used as crown lines during installation. The design life of the mooring is in excess of five years; hence the requirement for nonrotating corrosion protected wire rope.

The assemblies shall include wire rope and fittings delivered on individual storage reels. Table 1.0-1 delineates each assembly.

3. PERFORMANCE REQUIREMENTS:

3.1 WIRE ROPE: The wire rope specified shall be a medium size, high strength, corrosion resistant wire rope exhibiting nonrotating characteristics and suited for marine use.

3.1.1 DIAMETER: The wire rope shall have a diameter of 1.25 inches plus or minus 0.05 inches. This diameter shall be that of the smallest circle containing the complete cross section.

3.1.2 LENGTH: The length for each wire rope assembly is shown in Table 1.0-1. Each assembly shall be made up of one continuous length of rope with no intermediate splices or fittings. Each assembly shall have a length tolerance of plus or minus 5 feet when measured from fitting to fitting.

3.1.4 CORROSION PROTECTION: Corrosion protection shall be provided in the form of galvanizing. The ropes shall be either drawn galvanized or hot dip galvanized.

TABLE 1.0-1

Assembly Designation	Length	Fitting Inside of Shipping Reel	Fitting Outside of Shipping Reel	Remarks
M-1U	2830'	Closed	Open	Upper half of mooring leg 1 to be deployed from ATF STDB winch
M-1L	5740'	Closed	Open	Lower half of mooring leg 1 to be deployed from ATF main winch
M-2U	2830'	Closed	Open	Upper half of mooring leg 2 to be deployed from ATF STBD winch
M-2L	5740'	Closed	Open	Lower half of mooring leg 2 to be deployed from ATF main winch
V-1	5740'	Closed	Open	Vertical leg 1 to be deployed from main winch
V-2	5740'	Closed	Open	Vertical leg 2 to be deployed from main winch
C-1L	2830'	Closed	Open	Lower half of crown line to be deployed from ATF STBD winch
C-1U	5740'	Closed	Open	Upper half of crown line to be deployed from ATF main winch

3.1.5 NONROTATING CHARACTERISTICS: The wire rope shall exhibit antirotation properties. A free hanging load shall not rotate more than 2 degrees per foot length of rope when loaded to 50% of its rated breaking strength.

The adherence to this antirotation specification shall be demonstrated by running a test sample and submitting results. The contractor shall demonstrate that the wire rope construction and fabrication techniques yield a final product with rotational characteristics within this specification.

3.1.6 WEIGHT: The maximum weight of the wire rope in air shall be 3.0 pounds per foot.

3.1.7 FLEXIBILITY: The wire rope shall be able to be stored on a 30-inch diameter drum without damage to the wire. The published minimum bend diameter of the wire rope shall be a maximum of 36 inches for working loads.

3.1.8 FABRICATION: The wire rope construction shall include preforming and pretensioning.

3.2 FITTINGS: The fittings shall be of the swaged socket type. They shall be modified commerical types with special provision for corrosion protection. The fittings shall be applied to commerical standards. The location of the fittings is shown on Table 1.0-1.

3.2.1 SIZE: All fitting bodies shall be of the nominal 1-3/8-inch size. The fittings shall be bored for the 1¼-inch wire rope rather than the 1-3/8-inch size.

3.2.2 CORROSION PROTECTION: Each fitting shall be hot dip galvanized for corrosion protection, prior to being swaged to the wire rope.

3.3 FITTING INSTALLATION: Each fitting shall be installed according to good commerical practices utilizing an appropriate swaging machine. Filler wires may be installed before swaging, if required. A tape boot is to be applied to act as a strain relief where the wire enters the fitting. This boot shall be at least 8 inches long. The fitting shall be painted with 2 coats of black exopy paint per commerical standards.

4. TESTS

4.1 ROTATION TEST: The wire rope assemblies shall exhibit nonrotating characteristics. The characteristics shall be demonstrated by submission of data from a sample test performed by the contractor. The data shall demonstrate that the wire rope meets the following:

A free hanging load shall not rotate more than two degrees per foot length of rope when the load equals 50% of the rated breaking strength of the rope.

The test data presented shall be for wire rope with a diameter of 1.25-inch. The test data must be for a wire rope of exactly the same configuration (number of wires, number of strands, construction technique, and fabrication technique) as that specified for procurement. A test report must be provided before final fabrication of the wire rope assemblies.

The test data shall demonstrate that the wire rope meets the rotation specifications.

4.2 TENSILE TEST: One sample is to be tested. The test will include pulling the sample to destruction in one cycle on a tension testing machine. Wire rope, sockets and socket installation must be identical to all assemblies listed in Table 1.0-1 except for length, application of boot and paint.

Galvanized sockets with filler wires, if required, are to be fitted with the exact procedure to be used in fabricating the other wire rope assemblies. The application of the boot and paint is not required for the test assembly.

This test is to be performed prior to the installation of the fittings on the other wire rope assemblies. A test report must be provided before final fabrication of the wire rope assemblies.

The load at failure of the wire rope assembly shall be a minimum of 150,000 pounds.

5. PACKAGING AND MARKING:

5.1 CABLE REELS: The wire rope shall be shipped on returnable reels furnished by the contractor and loaded according to Table 1.0-1. Each assembly shall be loaded on a separate reel. The reels shall be of the smallest standard size which will accommodate the wire rope being shipped. The Government will return the empty reels.

5.2 IDENTIFICATION MARKING: Reels shall be marked as follows in addition to the address markings specified in the General Paragraphs. Both ends of the reel shall be stenciled or lettered in accordance with MIL-STD-129 with waterproof ink or paint as follows:

Contractor's name and address

Quantity, and manufacturer's purchase description code number from Table 1.0-1

Contract number

Net weight of cable

Marking shall be provided in 4-inch high letters.

APPENDIX G

CROWLEY MARITIME *CORPORATION*
OPERATIONS PROCEDURE
FOR THE
SQUAW MOORING PROJECT
NAVY TASK NO. 0004
CONTRACT NO. N00024-76-A-2035

OPERATIONS PROCEDURE

Day 1-3	Load all equipment stored at Merritt Shipyard on the M/V MANATI. Equipment will be secured for sea and ready to operate.
Day 4-5	Transit to San Diego.
Day 6	Mobilize all additional equipment at San Diego.
Day 7	Transit to mooring site 45 miles at sea. Tug will tow Squaw from San Diego to mooring site.
Day 8	Lay mooring leg No. 1 from bow of Squaw (see Figures II and III). Set bow anchor.
Day 9	Rig M/V MANATI for laying stern anchor.
Day 10	Lay stern anchor. Tension anchor system between bow and stern anchors to maximum of 32,000 lbs., or to U. S. Navy representative's approval. This will be accomplished by using the tug and pulling on the stern anchor crown line.
Day 11	Rig counter weight lowering system on M/V MANATI (see Figure IV).
Day 12	Rig and lower No. 1 counter weight. Rig No. 2 counter weight. Lower No. 2 counter weight.
Day 13	Submerge Squaw to 300 ft. Stand by for check out, until everyone is satisfied that it is a good mooring.
Day 14-15	Transit to port.
Day 16	Demobilize.

SUMMARY

Crowley Maritime Corporation will provide all equipment and personnel needed to accomplish the SQUAW mooring project as shown in fold-out.

All anchor/rigging will be connect/assembled according to plan furnished by the U. S. Navy. Any parts or assemblies that do not mate will be modified to U. S. Navy approval.

RESPONSIBILITIES

U. S. NAVY

1. Deliver Squaw to Crowley Maritime Corporation ready for tow to site. Towing lights and tow line attachment point should be readied for sea.
2. Furnish all mooring/anchoring material for four anchor legs.
3. Ship all Government furnished equipment to a designated location for the contractor to receive, assemble and load out.
4. Furnish two acoustic releases, including the interrogator for the system.
5. Rig all four of the anchor points on the Squaw hull ready to receive each mooring leg.
6. Furnish tension measuring system for anchor legs one and two. Operate the same.
7. Furnish charts of the area, showing latitude and longitude of Squaw mooring site.
8. Operate flood valve when Squaw is submerged.

CROWLEY MARITIME CORPORATION

1. Provide and operate one 210' offshore supply boat and one tug boat for the Squaw moor.
2. Receive all Government furnished material. Assemble and rig on the deck of M/V MANATI for mooring Squaw.
3. Receive Squaw from the U. S. Navy after inspection. Tow the Squaw to location identified by U. S. Navy (about 45 miles off San Diego, CA).
4. Furnish navigation equipment for positioning Squaw at position furnished by U. S. Navy.
5. Rig and install all four mooring legs. Tension mooring legs to Navy specifications.
6. After Squaw is flooded down assist Navy in evaluation of moor.

EQUIPMENT TO BE FURNISHED

U. S. NAVY

1. Squaw, rigged and equipped to receive four anchor legs.
2. Squaw readied for tow to sea.
3. All components for each anchor leg from hull fittings on Squaw to and including the anchors.
4. One 12,000 ft. reel of 1-1/8" wire rope for lower anchor systems.
5. Two 1¼" carpenter stoppers, two 1" carpenter stoppers
6. Two 45,000 lb. acoustic releases and interrogators

CROWLEY MARITIME CORPORATION

1. One 210 ft. offshore supply boat
2. One tug boat
3. One Skagit double drum winch R.B. 150
4. One beach gear winch double drum
5. One set of beach gear tackle
6. Two crown buoys
7. One welding machine, leads and accessories
8. One burning rig with accessories
9. Miscellaneous rigging gear pendants, shackles, etc.
10. Two sets of diving gear
11. One work boat with motor
12. One rubber tire crane, capacity 5 ton
13. Communication equipment for on-site operation between three platforms

OUTFITTING
M/V MANATI

The M/V MANATI will be outfitted with a double drum Skagit winch with capacity to spool 8,570 feet of 1¼" wire on one drum and 8000 feet of 1-1/8" lowering wire on the second drum. See Figure 1.

There will be a double drum beach gear winch capable of lowering each anchoring system over the stern. The stern of the MANATI will have launching racks and heavy sheaves for lowering the anchor systems over the stern.

Other equipment to be carried on board the MANATI is as follows:

1. A rubber tire crane on board with 5 ton capacity for handling heavy rigging.
2. A portable trailer can be on board for sleeping quarters for additional personnel.
3. Supplies for crew and additional personnel
4. Life saving equipment for all personnel
5. First aid equipment and supplies.

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