No # 516

Dillingham

HAWAII DEEP WATER CABLE PROGRAM

AT-SEA TEST PLAN

November 10, 1989

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AT-SEA TEST - OPERATIONS PLAN

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I. INTRODUCTION

A. SCOPE

This document describes the equipment and operations planned for the At-Sea Test Phase of the Hawaii Deep Water Cable Program. This phase is being performed by Dillingham Construction Pacific, LTD. (Dillingham) of Honolulu, Hawaii, and its principal subcontractors:

- Makai Ocean Engineering (MOE) of Honolulu, Hawaii
- Edward K. Noda & Associates (EKNA) of Honolulu, Hawaii
- Evans-Hamilton, Inc. (EHI) of Houston, Texas
- Oceano Instruments, USA (Oceano) of Seattle, Washington
- Coflexip & Services, Inc. (Coflexip) of Houston, Texas
- Naval Ocean Systems Center (NOSC) of San Diego, California
- Hawaii Undersea Research Laboratory (HURL), of Honolulu, Hawaii

Table IB.1

SUMMARY OF ALENUIHAHA CHANNEL CABLE ROUTE

PATH SECTION	MINIMUM WIDTH	REQD. LAYING ACCURACY	MAX SLOPE	CURVATURE RADIUS	BOTTOM CABLE TENSION (SURROGATE)	PREDOMINANT CURRENT DIRECTION (1)	DEPTH RANGE
	(M)	(M)	(DEG)	(KM)	(KG)	(DEG)	(M)
1	390	61.0	10	1.4	1095	90-30	400-850
2	170	24.0	10	0.65	1095	30-150	850-1100
3	80	11.5	10	1.0	1095	150-90	1100-1400
4	500	79.0	8	>10.0	1095	90-80	1400-1700
5	500	79.0	4	10.0	1095	80-95	1700-1920
6	200	29.0	30	>10.0	365	90-120	1920-900
7	500	79.0	4	>10.0	1095	120-90	900

(1) Relative to cable laying direction

(Adapted from "Conceptual Design of Reduced Scale At-Sea Test", January 1987, Table 3.2, for commercial cable).

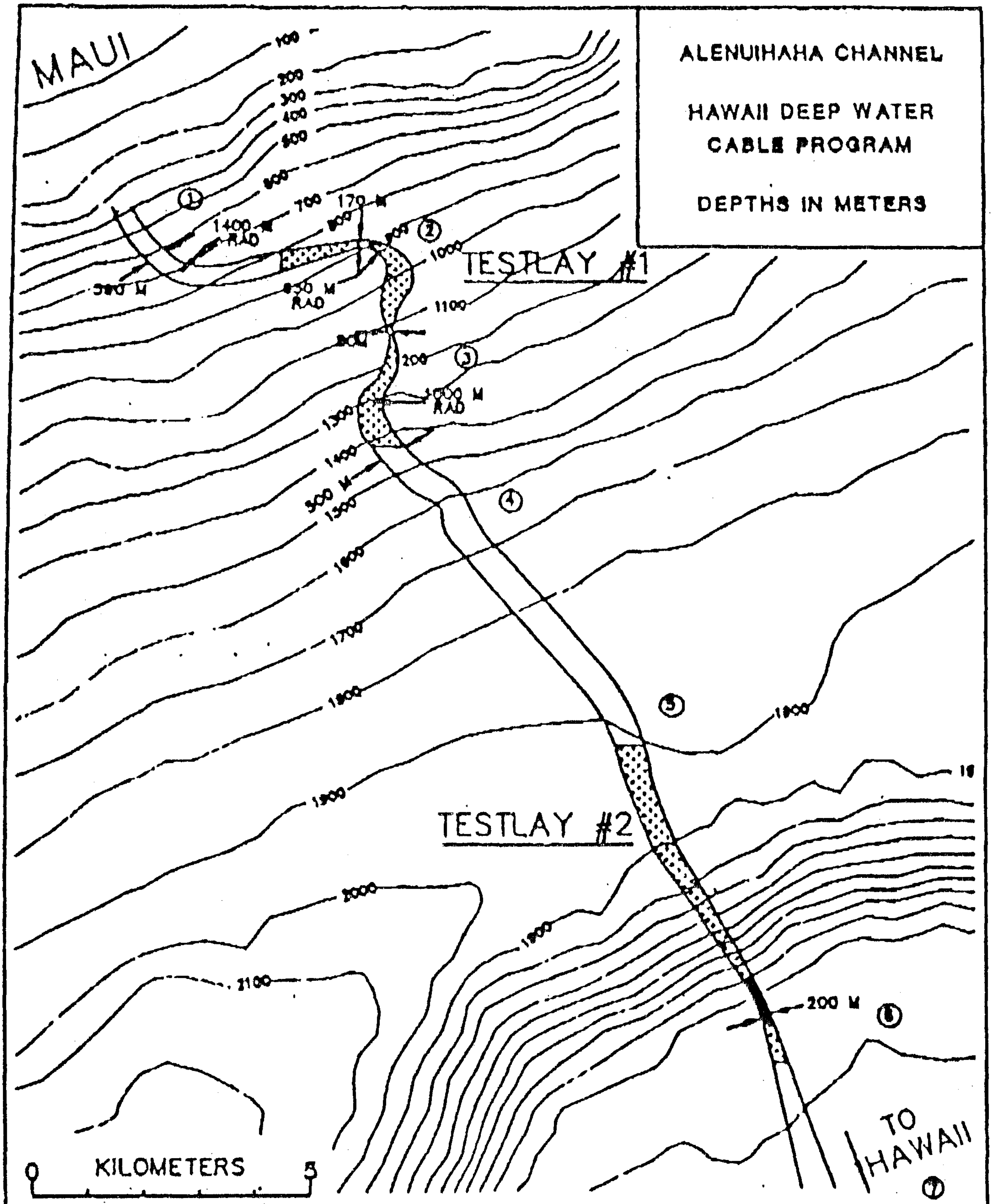


FIGURE 2 AT-SEA TEST LAY

FIGURE IB.1

The cable tensions on the bottom will be measured by the Pisces with a clamp on tensiometer. The Pisces observer will also inspect the cable to verify that the cable is laid without loops or excess cable on the bottom <indicating 0 tension> and without excessive cable spans <indicating large tensions>.

Success of controlling tension is determined by the following factors:

If the measured cable tension is less than or equal to the maximum values allowed, and the cable is laid on the bottom in a straight and uniform path, then the cable tension has been successfully controlled.

If there are unacceptable spans but the cable tensions are below the maximum values, the cable lay tension control objectives have been met; however, the cable route and/or tension control objectives may have to be redefined.

If the Pisces observes a non straight bottom cable or loops in the cable, the cable was laid at 0 tension and that portion of the cable lay is unsuccessful.

If the Pisces inspection indicates that cable tensions are greater than the maximum allowed values, that portion of the cable lay is unsuccessful.

There is a possibility that the success of the At-Sea Test will only be known after post-cruise analysis of the data. Any one of a multitude of systems, equipment, and previous research could greatly impact the outcome of the at sea testing. Post-processing of data collected during the test could lead to the identification and correction of a specific error. Computer simulation of the cable lays using the At-Sea Test data with corrected input could demonstrate the technical feasibility.

Two examples of post test analysis and correction of At-Sea Test results are:

The available seabed data, if incorrect, could result in a cable lay on terrain different than planned with unintended spans and tensions. However, if analysis shows that the cable was laid on the intended path, the conclusion would be that the cable laying system works as intended, but that the path needs to be resurveyed.

High ambient noise from the Flexservice 3 could result in significant error in the acoustic navigation system which locates the position of the cable for the ICS. Post processing of the ANS data could provide improved cable position data. Simulation of the cable lays with improved data could show that the cable could be controlled by the ICS and ship provided that the ANS performance is improved. The conclusion would be that cable laying system works, but control of ambient noise is required.

In any case, the outcome of the AT-SEA TEST will be fully documented in the AT-SEA TEST FINAL REPORT.

C. GENERAL DESCRIPTION OF THE TEST

The ships and components of the HDWC At-Sea Test are depicted on Figure IC.1 to illustrate the interaction of vessels and systems. The cable will be laid from the Flexservice 3 (FS3). The test will be conducted in the Alenuihaha Channel as shown on Figure IC.2.

The FS3 will house the surrogate cable, the Integrated Control System (ICS) van, Data Acquistion System (DAS), Acoustic Navigation System (ANS), Surface Navigation receivers, and cable tensioners. The FS3 will receive directions regarding ship position (course and speed), and cable payout rates from the ICS.

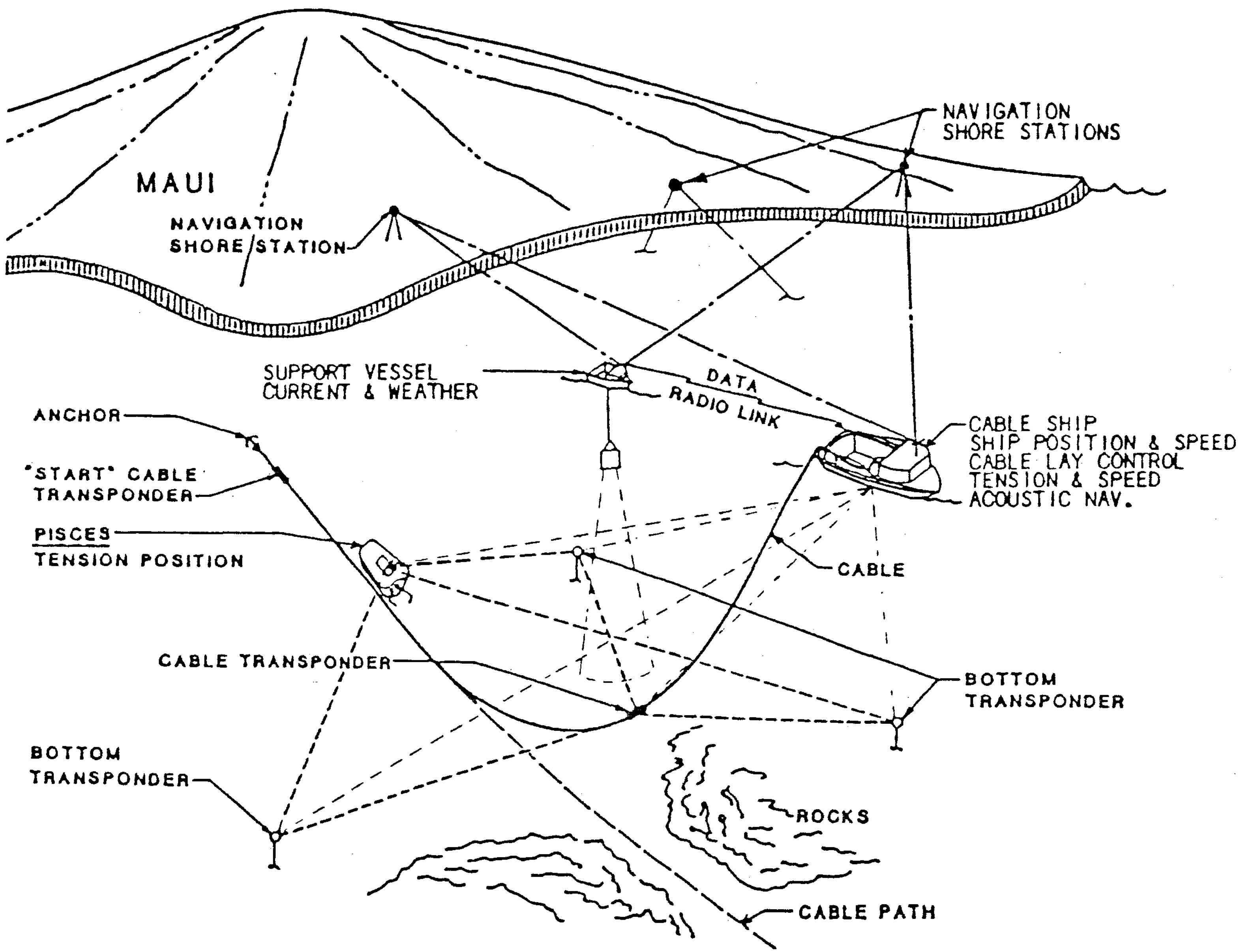
The SSP KAIMALINO will house the Acoustic Doppler Current Profilers (ADCP) and transmit current profiles to the ICS via the Data Acquisition System and a radio frequency modem. The ICS uses these data to calculate and forecast the deflection of the cable caused by ocean currents.

The surface navigation stations and ANS seabed transponder grids were installed and tested during the Shakedown Cruise (SDC). These networks establish the surface positions of the ships and the surrogate cable position under the ocean surface. The SDC accomplishments will be fully documented in the AT-SEA TEST FINAL REPORT.

The manned submersible Pisces, operating with its own support vessel Kila, will dive to the ocean bottom to verify the location and measure the tension of the laid cable and observe free span lengths. The Pisces operates semi-automonously although its dives are monitored and coordinated with the cable laying by the At-Sea Test Director.

All project systems and equipment were tested during the Shakedown Cruise with the exception of the Flexservice 3. The

FIGURE IC.1



Ships and Components of the HDWC At-Sea Test

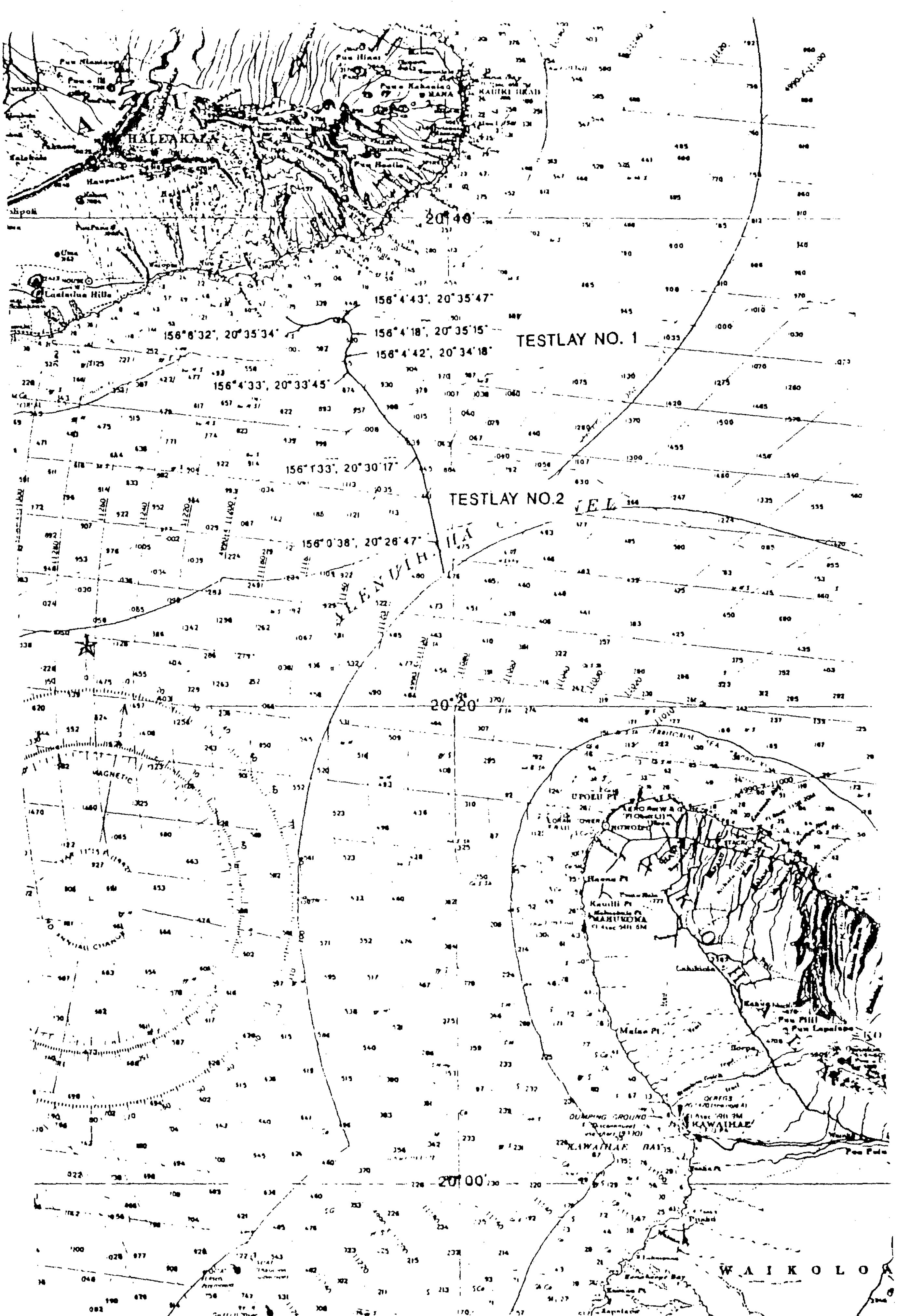

HALEAKALA
TESTLAY NO. 1
TESTLAY NO.2
156°4'43", 20°35'47"
156°6'32", 20°35'34"
156°4'18", 20°35'15"
156°4'42", 20°34'18"
156°4'33", 20°33'45"
156°1'33", 20°30'17"
156°0'38", 20°26'47"
20°40'
20°20'
20°00'
KAWAIHAE
W A I K O L O

FIGURE IC.2

FS3's dynamic positioning system and cable handling system will be inspected in Houston during the Dockside Acceptance Test. A final operational test will be performed offshore Honolulu during the Sea Trials preceding the At-Sea Test.

D. LIMITATION OF COST

All work on this project is governed by Federal Acquisition Regulations and is only one portion of overall requirements which include a "Limitation of Cost" clause. The Limitation of Cost clause in the contract provides that the government is not responsible to pay costs that are greater than authorized.

A budget for each operation has been established, and funding has been authorized in the amount of the budget estimate. Job conditions, last minute circumstances, weather delays, or any other circumstances do not create an obligation for the government to pay additional costs. It is necessary for each subcontractor to manage its work in such a manner that its demobilization from the project is completed before the authorized funds are expended. Section V.J Operational Cost Containment Plan contains a detailed explanation of action to be taken to control cost.

The Limitation of Cost provisions also call for each subcontractor to promptly notify the client when cost forecasts show that additional funds will be required to complete the subcontracted Scope of Work.

II. ORGANIZATION AND STAFFING

A. ORGANIZATION

The organization of the personnel and assets participating in the At-Sea Test needs to be considered in three simultaneous contexts:

CONTRACTUAL ORGANIZATION

With the exception of the cable manufacturing company representative consultant engaged by the client company to observe the At-Sea Test, all contractors and equipment working on the At-Sea Test are subcontractors to Dillingham. Each organization is bound by a formal subcontract, with limitations of cost and other provisions. This organization is shown in Figure IIA.1. Certain organizations, while subcontracted to Dillingham, will take technical direction from E.K. Noda.

SAFETY ORGANIZATION

In the event of conditions which, in the opinion of the Master of each vessel, threaten the safety of that vessel, such Master is empowered to take whatever actions he deems fit to protect the safety of the vessel and crew. In such a situation all other personnel revert to the status of passengers.

FUNCTIONAL ORGANIZATION

The basic organization under which the work will be carried out is illustrated in Figure IIA.2.

CONTRACTUAL ORGANIZATION

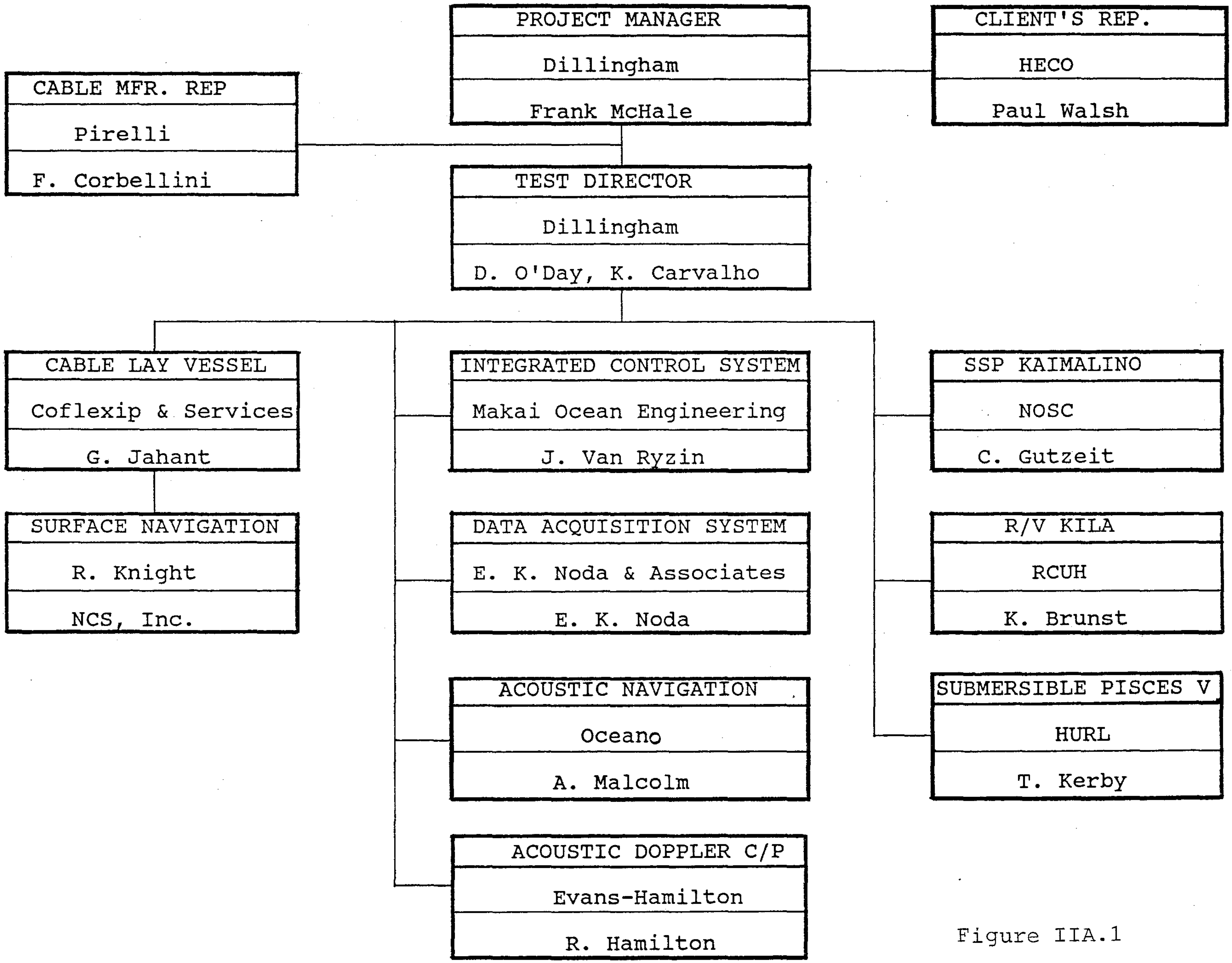


Figure IIA.1

FUNCTIONAL ORGANIZATION

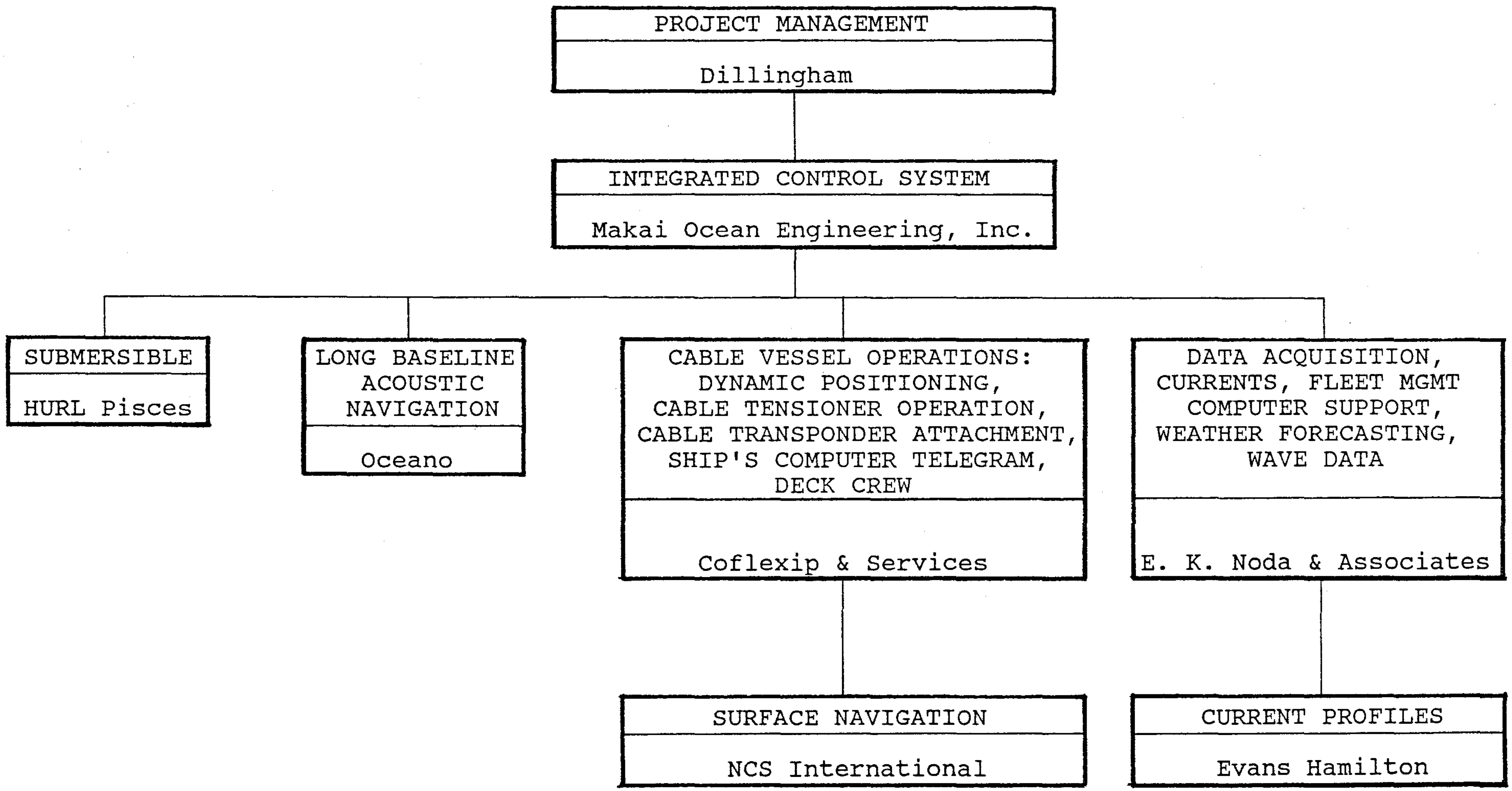


Figure IIA.2

B. AT-SEA TEST DIRECTOR

ROLE

Overall supervision and direction of AST activities.

- o The Dillingham Project Manager/Technical Director is in direct charge of all subcontractors on the project team.

- o Each functional area (ICS, DAS, ANS, ADCP, SURFACE NAV, PISCES and vessel operational personnel) is planned to function semi-autonomously during lay and recovery, with pre-planned interfaces.

- o The primary Technical Director role is to monitor the operations of the technical systems and operations implementing the AST Plan, and to step in with decisions or changes when necessary.

RESPONSIBILITIES

- o Ensure execution of checklists and operating plans in the AST plan.

- o Resolve changes, disputes, and problems which can not be resolved at lower levels or have important cost/scheduling implications.

- o Assemble, review, and issue operational plans for each successive shift.

- o Report progress and fleet intentions to client's representative and other external parties as required.

- Provide environmental and operational information to HURL personnel so they can execute *Pisces* dives and achieve their objectives.

- Maintain on-going written events log.

INFORMATION REQUIREMENTS

To assist in execution of the At-Sea Test Director's specific tasks, a work station and small conference room will be established in the ICS control van onboard the *Flexservice 3*. The control van description is contained in the equipment and arrangements section of the appendix.

C. PROJECT STAFF BY VESSEL

FLEXSERVICE 3 PERSONNEL

DILLINGHAM CREW (3)

Test Director (1) - Shifting - Supervises and directs all subcontractors on all vessels and ashore. Responsible to the client for the success of the At-Sea Test.

Assistant Test Director (1) - Shifting - Assumes the duties of the Test Director when on shift. Notifies the Test Director of extraordinary events.

Power Cable Consultant (1) - Non-Shifting - Observe, consult, report on At-Sea Test aspects affecting power cable work.

HAWAIIAN ELECTRIC COMPANY CREW (1)

Technical Representative (1) - Non-Shifting - Observe all aspects of the project, and consult with Dillingham Project Manager. Not contractually authorized to direct work or order changes.

COFLEXIP CABLE CREW (11)

Offshore Manager (1) - Non-Shifting - Responsible to Dillingham Project Manager and supervises all Coflexip personnel including marine crew.

Offshore Engineers (2) - Shifting - Report to Offshore Manager and supervise Deck Crew; carry out all details of operation to support client's plans. Operate the ship's computer. Supervise Deck Crew who are responsible to carry out instructions from client. Supervise surface navigation (radiolocation) subcontractor.

Deck Crew - Shifting - (6 per shift). Tensioner Operator (receives instruction from Makai); Winch Operator (monitors level wind; adjusts torque to maintain back tension); Crewmen (deploy the ANS cable transponders when instructed; Adjust the depth of the ANS baffled acoustic module; Perform line handling, other normal Deck seaman duties.) Includes working leadman or foreman, who reports to Offshore Engineer.

Radiolocation Subcontractor (2) - Shifting - Monitor and calibrate shore based positioning system; responsible to furnish continuous ship position. (Additional personnel required on shore to maintain shore stations). Report to Offshore Manager.

Electrical Technician, Mechanical Technician (2) - Non-Shifting - Responsible for maintenance and repair of all deck equipment except computers. Report to Offshore Manager.

COFLEXIP MARINE CREW (15)

Master (1) - Shifting - During the cable lay operations the Master reports to the Offshore Manager except in case of threat to safety when the Master takes command.

Chief Officer (1) - Shifting - Assumes the duties of the Master when on shift. Notifies the Master of unusual events in accordance with Master's standing instructions.

DP Operators (2) - Shifting - The DP operator reports functionally to the Master but receives DP operating instructions directly from Makai.

Chief Engineer (1) - Non-Shifting

1st Engineer (1) - Non-Shifting

Ship's Electrician (1) - Non-Shifting

Cook, Helper,Steward (5) - Non-Shifting

Crew (3) Shifting

MAKAI OCEAN ENGINEERING CREW (6)

ICS Manager (1) - Non-Shifting - Supervises all Makai personnel in operating, maintaining, all functions of ICS.

ICS Engineers (5) - Shifting - Operate Integrated Control System.

E.K. NODA CREW (3)

DAS FMCS and Peripheral Equipment Operators: (3) - Shifting

OCEANO INSTRUMENTS USA, INC.

Acoustic Navigation System Operators: (2) - Shifting -SSP Kaimalino Personnel.

DILLINGHAM CREW

Assistant Test Director (1) - Non-Shifting - Supervises the subcontractors onboard the Kaimalino. Responsible to the Test Director.

E.K. NODA CREW

S/V Manager (1) - Edward K. Noda - Non-Shifting

DAS, and Navigation System Operators (2) - Shifting

Winch Operators (2) - Non-Shifting - operate the ADCP markey winch and assist with the deployment of ADCP apparatus.

EVANS-HAMILTON, INC. (2)

ADCP Operator (2) - Shifting - Operate the ADCP system when deployed.

KAIMALINO CREW

Marine crew (7) - Shifting - operates the support vessel and assists with deployment of the ADCP equipment.

III. SCHEDULE

A. GENERAL

The At-Sea Test schedule is contingent upon the arrival date of the Flexservice 3 (FS3) in Honolulu. This date is projected to be October 13, 1989. One month prior to the arrival date the vessel owner, Coflexip & Services, Inc., will establish a one week window. During the voyage from Houston to Honolulu, Coflexip is to update the arrival date every other day. (In all HDWC planning, the Honolulu arrival date of Flexservice 3 is identified as the start date (Day 1) for the At-Sea Test).

Upon notification of the one week window, the At-Sea Test Director will calendarize the At-Sea Test schedule and notify all project subcontractors to mobilize their equipment and personnel. Until then, the schedule will be referenced to an unspecified arrival date of the FS3. Figures IIIA.1 and IIIA.2 summarize the daily schedule before and after the arrival of the FS3.

DAILY SCHEDULE

1. DAY -7

Six days prior to the arrival of the FS3, the support vessel Kila will be mobilized at Snug Harbor. A complete shipboard Acoustic Navigation System, the Falcon Mini-Ranger System, and spare seabed transponder assemblies will be installed onboard the Kila. The navigation system will be made to directly interface with the ANS. A V-fin with 100 meter faired EM cable will be used to deploy the ANS acoustic module from the Kila's winch. At the Waimanalo pier, the Pisces will be loaded upon its deployment barge or LRT.

2. DAY -6

The Kila will depart Snug Harbor with two Oceano ANS operators onboard and transit to the Hawaii Underwater Research Laboratory facility at the Makai Pier in Waimanalo. The Kila will take the Pisces LRT in tow, transport the Pisces to Kawaihae Harbor, and then transit to the Alenuihaha Channel. The Pisces and crew will remain in Kawaihae Harbor until needed.

The Mini-Ranger Navigation shore stations will be set up and activated on Maui by the Coflexip radiolocation subcontractor.

3. DAY -5

Oceano personnel operating from the Kila will reactivate and recalibrate the underwater navigation grids at both testlay sites. Any malfunctioning seabed transponders will be deactivated and replaced with recoverable transponders. The Kila will return to Kawaihae Harbor upon completion.

4. DAY -4

The Kila will take the Pisces in tow and transit to Testlay Site # 1. The Pisces will dive to establish an electronic waypoint in the middle of the Maui narrows and locate its edges in the ANS grid.

5. DAY -3

Following the first dive, the Pisces will be serviced in preparation for Dive #2. Service may be accomplished in sheltered waters or in port, contingent upon the weather and sea state. Dive 2 is a contingency dive to be executed in the event that Dive 1 does not complete its objectives.

6. <u>DAY -2</u>

This day is set aside for Dive 2. The weather monitoring plan will be implemented as described in the operations planning and documentation section of this plan.

7. <u>DAY -1</u>

The <u>Pisces</u> will be serviced in Kawaihae Harbor. Oceano personnel will disembark the <u>Kila</u> immediately upon entering Kawaihae Harbor and transfer themselves and equipment to Honolulu for mobilization onboard the <u>Flexservice</u>.

8. <u>DAY 1</u>

The <u>Flexservice 3</u> will arrive in Honolulu and berth at Snug Harbor, Pier 45. The ICS control van will be installed onboard the <u>FS3</u> along with associated ICS/DAS/ANS computers and peripherals.

The <u>Kila</u> will deploy the EKNA waverider buoy in the Alenuihaha Channel.

The <u>Kaimalino</u> will transit to Snug Harbor and begin mobilization.

9. <u>DAY 2</u>

The <u>FS3</u> and <u>Kaimalino</u> will continue equipment mobilization at Snug Harbor. The Coflexip surface navigation subcontractor will install Microfix equipment at the Maui shore stations.

10. DAY 3

The FS3 will depart Snug Harbor and conduct Sea Trials offshore of Honolulu. These trials will test the ship's systems interaction with the Integrated Control System. A complete description of the test is contained in the operations section of this plan.

11. DAY 4

The FS3 and Kaimalino will transit to the Alenuihaha Channel.

12. DAY 5 - 14

The FS3 and Kaimalino will be joined by Kila and Pisces to conduct the At-Sea Test of the cable laying system. At a time, not yet determined, the Kaimalino will transit to Kawaihae Harbor to refuel. This will be scheduled to occur while the FS3 is retrieving cable. The At-Sea Test operations may be completed prior to day 14 if the objectives and criteria for success are achieved early. Due to budgetary considerations, the At-Sea Test will not be allowed to extend beyond day 14.

13. DAY 15

Upon completion of the At-Sea Test operations, the FS3 and Kaimalino will return to Snug Harbor to demobilize equipment. The Kila will tow the Pisces to its pier at HURL. All surface navigation stations will be demobilized.

14. DAY 16

The FS3 will offload all AST related equipment. The 8 kilometers of surrogate cable will be spooled onto a reel on the dock for disposal by Parsons Hawaii. The FS3 will be released. The Kaimalino will be released as soon as it is offloaded and returned to its home berth in Kaneohe. The Kila will return to Snug Harbor.

15. DAY 17

An early morning debriefing will be held for key project personnel to discuss the At-Sea Test operations, documentation, and data transfer for compilation of the At-Sea Test report.

B. AT-SEA TEST CABLE LAYING

One of the critical factors in establishing the schedule is to plan the *Pisces* dives in order to meet dive safety restrictions. The main constraint is that the recovery cannot be performed at night. However, when a dive is completed at night, the *Pisces* can wait on the bottom for daylight. Another important factor is that 24 hours of surface time is required between two dives in order to perform checks and maintenance. This means that the *Pisces* will dive every 30-32 hours while a complete test lay cycle requires approximately 34-38 hours (i.e. lay and recovery). Considering an 8 hour dive for the *Pisces* and a 36 hour test cycle, a target schedule is as follows: (assuming daylight from 6 a.m. to 6 p.m.)

OPERATION	HRS.	PERIOD	DAY
Marine Spread Transit From Honolulu	11	0600-1700	1
Preliminary trials, nav. check	37	1700-0600	3
Lay 1, path #1			
Establish Location, set up test	4	0600-1000	3
Cable Lay	16	1000-0200	4
Pisces Inspection	8	0000-0800	4
Cable Recovery	16	0200-1800	4
Lay 2, path #2			
Establish Location, set up test	4	1800-2200	4
Cable Lay	16	2200-1400	5
Pisces Inspection	8	0800-1600	5
Cable Recovery	16	1400-0600	6

In the first lay, the PIsces will inspect the cable starting near the end of the lay and going backward to the anchor, viceversa in the second one.

This 3-day cycle for 2 laying operations will be repeated until the primary test objectives have been met.

AT-SEA TEST DEPLOYMENT SCHEDULE

DAYS	-7 10/13	-6 10/14	-5 10/15	-4 10/16	-3 10/17	-2 10/18	-1 10/19
<u>FS3</u>							
<u>KILA</u>	MOBILIZE EQUIPMENT	OFFLOAD <u>PISCES</u> TRANSIT TO KAWAIHAE	ANS ACTIVATE TAKE <u>PISCES</u> IN TOW FROM HONOLULU				
<u>PISCES</u>	PREOPERATIONS SERVICE DAY <u>PISCES</u>/MOE DIVE PLANNING MEETING	TRANSIT TO KAWAIHAE	IDLE KAWAIHAE	DIVE #1 MAUI NARROWS	SERVICE DAY #1	CONTINGENCY FOR DIVE # 2	CONTINGENT SERVICE DAY #2
<u>Kaimalino</u>					COMPLETE CRUISE FOR GOVERNMENT PROGRAM		
MISC.	INSTALL RADIO BASE STATION ONBOARD KILA				EKN COMMENCE WEATHER MONITORING		

AT-SEA TEST DEPLOYMENT SCHEDULE

DAYS	1 10/20	2 10/21	3 10/22	4 10/23	5-14 10/24-11/2	15 11/3	16 11/4
FS3	ARRIVE HONOLULU MOBILIZE EQUIPMENT	MOBILIZE EQUIPMENT	SEA TRIALS OFFSHORE HONOLULU	TRANSIT TO AL'HAHA CHANNEL	10 DAYS AT-SEA TEST	TRANSIT TO HONOLULU	DEMOB. EQUIP.
KILA	KILA DEPLOY WAVERIDER BUOY			AST ONCALL TO TAKE PISCES IN TOW			
PISCES	STANDBY UNTILL TEST			ON CALL TO COMMENCE AST DIVES (SCHEDULED)			
Kaimalino	TRANSIT TO SNUG HARBOR	MOBILIZE EQUIPMENT	SEA TRIALS	TRANSIT TO CHANNEL	AST	TRANSIT TO HONOLULU OFFLOAD	COMPLETE OFFLOAD TRANSIT TO KANEOHE
MISC.	INSTALL RADIO BASE STATION FS3 & SSP				TBD Kaimalino REFUEL KAWAIHAE		

AT-SEA TEST DEPLOYMENT SCHEDULE

DAYS	-7 10/13	-6 10/14	-5 10/15	-4 10/16	-3 10/17	-2 10/18	-1 10/19
SURF NAV	INSTALL MINIRANGER MASTER ON KILA	INSTALL MINIRANGER SHORE STATIONS				RACAL ARRIVES AIRPORT	
CONTROL VAN MOB DOCK	INSTALL ICS/FCMS BASE STATION		INSTALL ICS COMPUTERS	ICS ACTIVATION UPS TESTING		COMPLETE ICS TESTING	TRANSFER VAN TO FS3
OCEANO	MOBILIZE ANS EQUPMENT					DISEMBARK KILA IF DIVE #2 NOT NEEDED	RETURN TO HONOLULU
EHI							

AT-SEA TEST DEPLOYMENT SCHEDULE

DAYS	1 10/20	2 10/21	3 10/22	4 10/23	5-14 10/24-11/2	15 11/3	16 11/4
SURF NAV	INSTALL MICROFIX ONSHORE MICROFIX SSP (EKN)					DEINSTALL SHORE STATIONS	
CONTROL VAN MOB	LOAD ONBOARD FS3						
OCEANO	MOBILIZE ANS ONBOARD FS3						
EHI		MOBILIZE EQUIPMENT ONBOARD SSP					

IV. OPERATIONS PROCEDURES

A. MOBILIZATION AT HONOLULU HARBOR

Prior to arrival of the Flexservice 3, the control van will be delivered and set up at Pier 45, Snug Harbor. The ICS, DAS, and ANS computer equipment will be installed in the van and made operational. Air conditioning will be provided. The van will be prepared for loading onto the Flexservice 3 as one unit, with only electrical connections remaining to be made to integrate the control van into the vessel when it arrives. Coflexip will be responsible for securing the van to the deck and performing the power attachment.

SSP Kaimalino will be outfitted with the Markey winch and the ADCP units, main and spare towframe, and main mounting staff. The arrangements will be the same as used previously for the Proof of Concept Cruise and Shakedown Cruise.

Acoustic transponders and hardhats for attachment to the cable will be in storage at Pier 45, ready for transfer to the Flexservice 3.

The Flexservice 3 is responsible for making its own arrangements as to bunkers, fresh water, provisions, other needs. Coflexip's landside coordinator will arrive at Honolulu one week before the vessel to make these arrangements.

Fixed project radios will be installed on Flexservice 3, Kaimalino and Kila. Hand-portable radios will be put aboard in accordance with the Communications Plan.

B. <u>SEA TRIALS OFF HONOLULU - FLEXSERVICE 3</u>

<u>OBJECTIVES:</u>

To test and check out all equipment that will be needed on the cable-laying vessel, (and which has not been exercised during the Shakedown Cruise) including vessel systems, and the Integrated Control System.

To conduct a trial run of the cable handling equipment and control system prior to mobilizing to Alenuihaha Channel.

To familiarize project personnel and gain experience in operating and coordinating the combined systems aboard the cable laying vessel.

<u>OPERATIONS:</u>

The <u>Flexservice 3</u> will transit to the south of Honolulu to an area with water depth approximately 500 m (1200 feet). The Coflexip Master will be requested to keep the vessel outside the 200 fathoms contour during the Sea Trials.

The test cable will be run out through the tensioners and overboard. The anchor which starts the cable lay will be attached to the cable and deployed. Under direction of the ICS, a simulated cable lay will be started.

For practice and rehearsal, two or more acoustic transponders will be attached to the cable while it is being payed out.

The ICS will issue movement commands to the DP by software display which have been planned to check the operation of the ship's thrusters. The ICS will issue commands to the tensioner operator by software to start, vary and stop the payout of cable.

The operation of the length measurement device of the tensioner will be observed and checked.

The Surface Navigation shore stations, and the seabed acoustic navigation bottom grid transponders, will not be deployed in the Honolulu area for the sea trials.

During these trials, SSP Kaimalino will accompany and practice station keeping on the Flexservice 3, but will not deploy the ADCP to depth.

The suspended cable and anchor will not be grounded on the sea bottom.

R/V Kila and submersible Pisces will not be present for these sea trials.

When the Test Director and ICS are satisfied that all systems are functioning satisfactorily, the Flexservice 3 and Kaimalino will depart for the Alenuihaha Channel.

C. PRE-CABLE LAY OPERATIONS - KILA/PISCES

OBJECTIVES:

The Pisces submersible and support vessel Kila will operate in the Alenuihaha Channel prior to the arrival of the cable vessel in order to carry out the following operations:

- To locate the narrow section of the Maui route within the geodetic coordinate system, by having Pisces dive to the narrows while being acoustically tracked by the Oceano ANS equipment on Kila. This will rectify the existing bathymetry charts.

- To enable, check and recalibrate the bottom mounted acoustic transponder grid on both the Maui and Kohala Testlay sites, by use of Oceano equipment on R/V Kila.

- To deploy retrievable transponder moorings from Kila (should Oceano determine that a bottom-mounted transponder is malfunctioning).

The above operations need to be performed sufficiently in advance of the arrival of the Flexservice 3 to allow:

- Contingency time for repairs.

- Time to allow for analysis and adjustment to bathymetry/coordinates if the Maui narrows dive indicates problems with this location data.

- Time to allow the Oceano ANS personnel and equipment to be demobilized from R/V Kila, returned to Honolulu, and to install their equipment on the Flexservice 3 prior to its departure.

If these operations can be completed with three or four days of stand-by time, the *Pisces* will perform some scientific dives for other clients in the Kawaihae area while awaiting the arrival of *Flexservice 3* and *Kaimalino*. The planned day-by-day schedule for Pisces is in Section III of this report.

OPERATIONS:

Surface navigation for this portion of the operation will utilize HURL's Mini Ranger Falcon system, set up at the project's Maui shore stations. The Oceano ANS system will be placed on *R/V Kila* in advance of the cruise, as charted on the project schedule.

The *Pisces* dives will be conducted in accordance with HURL's standard operating and safety procedures.

D. SEA TRIALS IN ALENUIHAHA CHANNEL

OBJECTIVES:

After arrival at the Alenuihaha Channel, the following initial tests and measurements have to be conducted at the test site before starting with the first cable lay, to check out and insure operation and integration of all systems:

- Cable drag coefficient measurements: this is a critical parameter in the cable control system and values from the literature are not accurate enough for this laying operation.

  The cable with an anchor at the lower end and instrumented with a set of transponders will be lowered. With enough information on the shape of the cable, the average drag coefficient can be computed.

  This value will be used to initialize the control system. The drag coefficient will be checked throughout the cable laying and a more accurate value, if developed, will be used by the control system in the succeeding lays.

- Length Measurement Checks: The ICS uses several distance and length measurements to calculate cable touchdown location, and these measurements, taken from different sources, have to be acceptably in agreement. Ship's position is measured by redundant surface radio navigation systems (Syledis and Microfix). Transponder locations are determined relative to an underwater acoustic navigation grid. The cable is marked every 100 m of its 8000 m length. The bathymetry is the result of a previous survey.

  Two kinds of cross-checking will be performed:

- The cable ship position will be monitored by the two surface radio navigation systems and the acoustic one. The three systems will be checked such that there is an agrement within the resolution of the acoustic system (i.e. + or - 3 m).

- Cable length, acoustic length measurements and bathymetry will be cross checked while lowering the cable. By knowing the position of transponders on the cable and the length of cable paid out, these two measurements can be checked. Bottom contact should be detected with the transponders and, knowing the cable shape based on currents, ship position and transponder location, the depth can be calculated and compared to the known bathymetry.

PROCEDURES:

- The Flexservice 3 and the SSP Kaimalino will transit to a point in approximately mid-channel, within range of the Micro-fix and Syledis shore navigation stations, and in water depth greater than 1000 meters (3330 feet). The surrogate cable end anchor will be deployed (with a transponder attached near the anchor) and ten meters of cable will be paid out by the Tensioner Operator.

- On SSP Kaimalino, both upper and lower ADCP instruments will be deployed.

- The ANS baffled transducer ("baffle") will be deployed over the side of the Flexservice 3 and lowered to operating depth.

- The Test Director (using the Operations Order Format) will conduct a radio check to ensure that all systems are operational: including ADCP, Acoustic NAV, Surface NAV, DAS, Fleet Management Computer, Wave Rider Buoy, and Displays at Tensioner Operator and DP operator stations.

- The Syledis radio navigation system will be checked against the Acoustic Navigation System. Both must agree as to the position of Flexservice 3.

- The ICS will issue commands to the Tensioner Operator to payout cable. The deck crew will attach transponders to the cable being paid out in accordance with a list previously prepared by Oceano and agreed to by ICS.

- The ICS will issue commands to the DP via software in order to move the ship through the water with the cable suspended below the FS3 and all systems operating. At this time the ICS will perform a check on the drag coefficient of the suspended cable.

- The Flexservice will stop and maintain position over a point. The Kaimalino will keep station on Flexservice. The ICS will calculate the current profile based on transponder data and the suspended cable shape based on current data. The calculated currents will be compared to the ADCP data and the computer transponder locations will be compared to real transponder positions.

- The Kaimalino will move away and remain within 2 miles of Flexservice. The ICS will direct the DP to put the Flexservice 3 through a series of planned maneuvers at moderate speeds in order to introduce significant motion, including dynamics, into the suspended cable. The ICS will be used to follow these motions. This will be a test of dynamics and the cable segment velocity portions of the Actual Path Calculator subroutine in the ICS programs.

- Exercise the Vessel Response Specifier subroutine of the ICS programs to provide instructions to the DP in order to have the suspended cable assume a predetermined shape.

- When all of the above operations have been successfully rehearsed, and all systems are operational, the Test Director will issue an Operations Order to begin laying cable.

E. <u>CABLE LAYING OPERATIONS - FLEXSERVICE 3</u>

The At-Sea Test plan is to perform several complete cable laying operations. The cable will be laid, recovered, laid again along the two selected paths crossing the Alenuihaha Channel.

Repetitive laying is necessary to meet the objectives of the At-Sea Test. A typical cycle will therefore be a laying followed by a recovery operation.

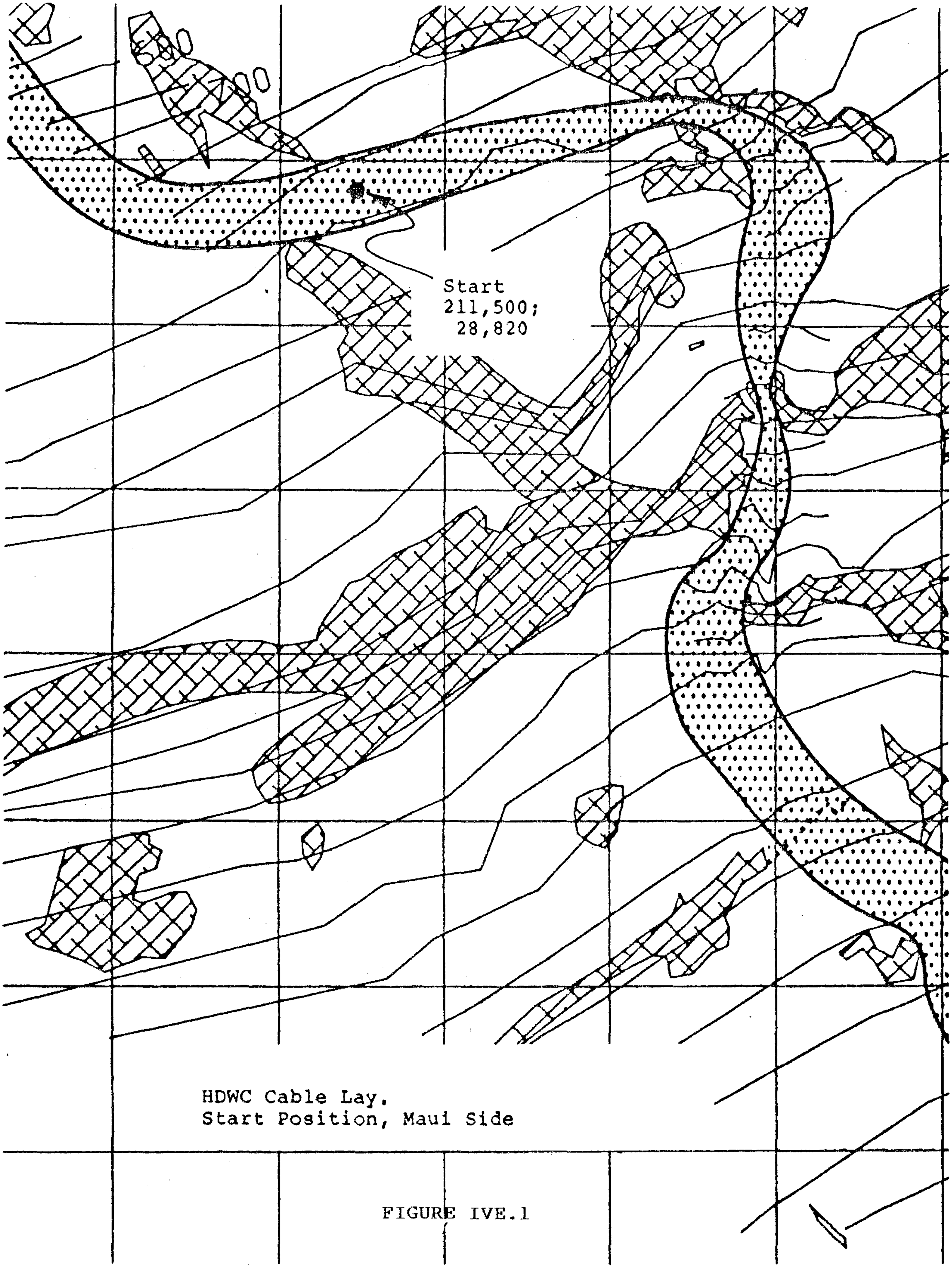
<u>ANCHOR DEPLOYMENT</u>

The operation will start by lowering the test cable from the laying vessel with a 3000-lb. anchor attached to the cable end, with a transponder positioned close to the anchor. Figures IVE.1 and IVE.2 show the cable lay starting points, at which the anchor shall be deployed.

The operation of attaching the anchor to the test cable and deploying the anchor will be done as follows: a messenger wire, either polypropylene or steel, is connected to the pendant shackle of the anchor and, passing through the overboarding sheave, is fixed on deck near the tensioner.

The anchor is raised from the deck using the <u>FS3</u> stern A-frame and lowered into the sea. Tension is maintained by a winch wire that passes through a sheave on the A-frame and connected to the other anchor shackle.

The cable head is then connected to the messenger wire and the tension is transferred from the winch to the tensioner. The winch wire is disconnected and the operations of lowering the anchor can start. It is important to connect the cable to the anchor pendant shackle to avoid problems during the recovery, if the anchor has been dragged.



HDWC Cable Lay,
Start Position, Maui Side

FIGURE IVE.1

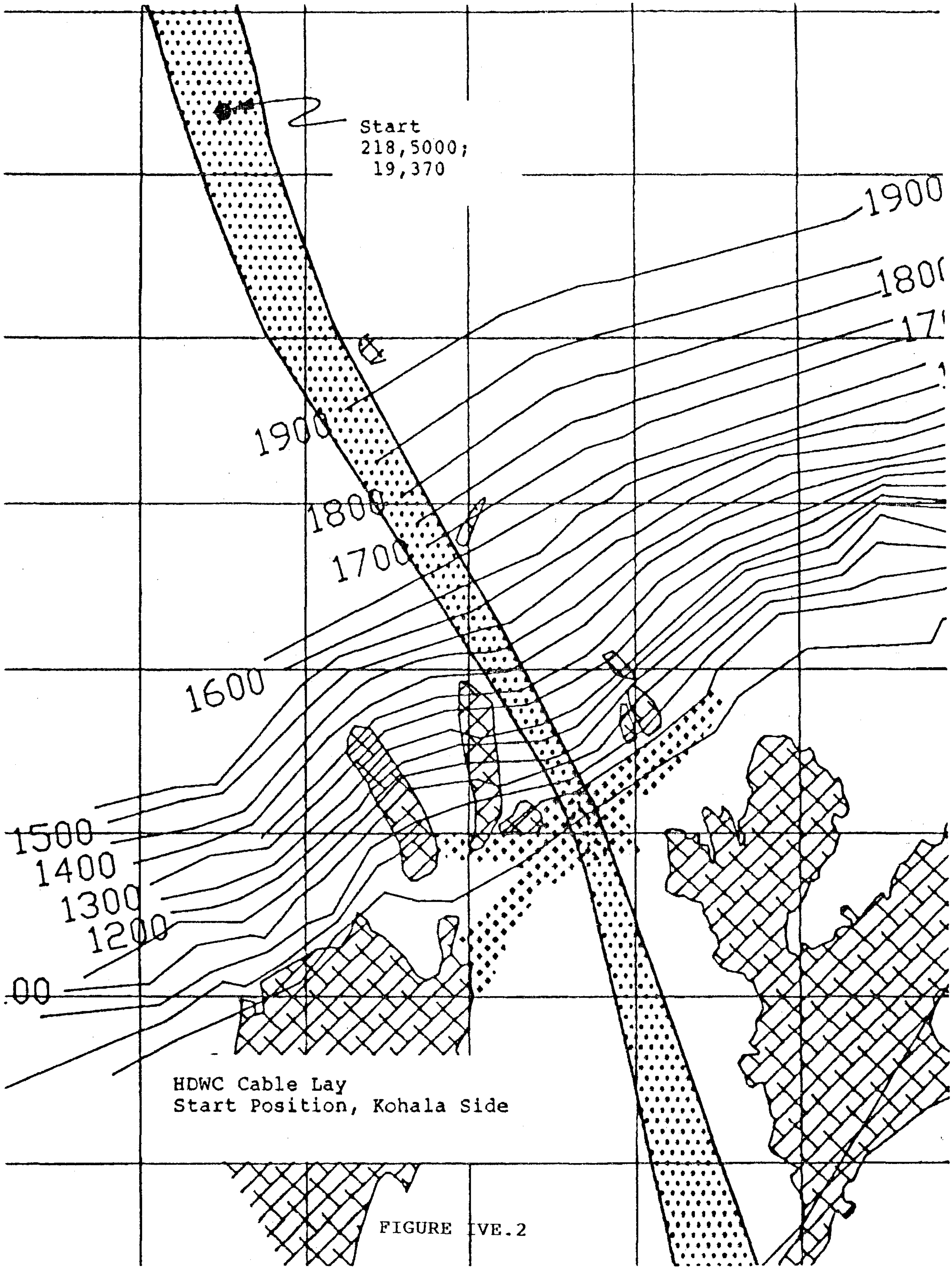

Start
218,5000;
19,370
1900
1800
1700
1600
1500
1400
1300
1200
.00
HDWC Cable Lay
Start Position, Kohala Side

FIGURE IVE.2

The polypropylene wire also functions to avoid possible cable damage (due to excessive bending) if the anchor touchdown is not promptly detected.

CABLE PAYOUT AND LAYING

The cable lowering will be monitored by ICS and the laying vessel will be guided into position in order to drop the anchor at the desired location. The ICS will then give instructions to the ship and Tensioner operator in order to reach the cable lay starting location. Upon reaching this starting position, both the ship and the cable payout will be stopped for several minutes in order to establish a stationary cable configuration. These maneuvers will be conducted with a relatively high bottom tension to minimize cable movement on the bottom. The laying operation then will start, with the control system directing cable payout and vessel positioning.

Each lay will be conducted in accordance with the pre-established plan for that particular path at a speed of approximately 10 m/min. The laying direction will always be from the Maui side to the Kohala side. The support vessel SSP Kaimalino will follow the laying operation maintaining a position near the cable touchdown point. This means, for example, that in 1,000 meters of water depth, the support vessel will stay approximately 150 m aft of the laying vessel if the cable bottom tension scheduled in that particular zone is to be 500 kg, or will stay 350 m aft if the scheduled cable bottom tension is 1700 kg. (The actual surface current and wind will dictate whether to stay port or starboard of the cable vessel). In this way the ICS will obtain near real-time current data (from the ADCP) relevant to the deep cable portion, which is more influenced by current variation.

Acoustic transponders will be attached to the cable at 300 meter intervals during the lay. In coordination with Makai, Oceano will prepare an acoustic transponder schedule prior to each lay, taking into consideration the frequencies available and the tested condition of each cable transponder. The transponders are to be attached without stopping the laying operation. The Coflexip deck supervisor is responsible for attaching the designated transponder in the correct sequence. The Test Director will observe and notify the ICS and ANS each tima transponder is launched. A detailed procedure for attachment and drawings for a temporary walkway on the vessel have been prepared by Coflexip.

In order to achieve the control accuracy required in particular sections of the laying route, the ICS may selectively call for attaching transponders to the cable. For example, transponders will be needed when nearing the narrowest section on the Maui side, in which a laying accuracy of $\pm$ 13 m is required.

The laying operation will continue until the control system instructs the ship and the tensioners to stop. This will happen either arriving at the end of the cable lay or if problems arise during laying.

In the first case a recovery operation will start, while in the latter case the Flexservice 3 DP will maintain position (and the tensioner will hold the cable) until the problem is corrected.

Note that this static configuration is independent of the control system, so problems within the ICS are not critical for cable safety.

While a cable lay is proceeding, the Pisces submersible will survey the cable to obtain data needed to determine whether the cable has been properly placed and tensioned on the bottom. Pisces will always be launched well aft of the cable touchdown location and will operate independently of the cable vessel.

The Test Director on Flexservice 3 will determine the launching position of Pisces. During the dive, the ANS will track and record the position of Pisces, which will be displayed on the Fleet Management Computer at the Test Director's workstation.

The Pisces will find the cable and follow it, recording its position. At specific locations, the Pisces will measure the cable tension. This last activity will be performed by means of a three point tension meter installed on the submersible. While tracking the cable, if free spans are detected, the Pisces will measure their lengths and record the locations.

The data obtained from the Pisces are not used as an active feed back in the control system but, as already stated, will be reviewed during the cable recovery operation to check the performance of the control system and to make adjustments in the laying procedure, as necessary.

During each test cycle (i.e. lay and recovery) the data acquisition system will acquire and record data from the ship's computer, the control system, and from hard wire or radio link connections to sensors on the cable vessel, on the support vessel and on the waverider buoy.

These data will be used after the test to evaluate the performance of the control system and to correlate the measured environmental conditions to the stern motions of the laying vessel and the resulting dynamic loads induced in the cable.

CABLE LAY - TEST DIRECTOR CHECK LIST FORM

1. BEFORE BEGINNING LAY: OPERATIONS ORDER

Lay Number: ____________________

Planned Track: ____________________

Seabed Starting x,y ____________________

Est. Lay Start Time & Date: ____________________

Est. Pisces Location

At Lay Start Time: ____________________

Weather Forecast: ____________________

Systems Out (if any): ____________________

Special Conditions (if any): ____________________

2. SYSTEMS READY CHECKOFF (RADIO):

		PERSON ON DUTY
ADCP	BY	____________________
ANS	BY	____________________
COFLEXIP DECK LEADER (INCLUDING XPDR LIST)	BY	____________________
COFLEXIP TENS. OPR.	BY	____________________
COFLEXIP DP OPR.	BY	____________________
DAS/SURF NAV	BY	____________________
KAIMALINO BRIDGE (ON STATION & READY)	BY	____________________
FLEXSERVICE BRIDGE (ON DP AT STATION & READY)	BY	____________________
ICS	BY	____________________

F. CABLE LAYING OPERATIONS - KAIMALINO

The assignment of the SSP Kaimalino as the Support Vessel during the At-Sea Test is to deploy the Acoustic Doppler Current Profile (ADCP) system and to house the data of the DAS primary consoles. Kaimalino was chosen to deploy the ADCPs because it is a SWATH vessel and the minimal surface motion of the ship will contribute to the accuracy of the current profiles obtained by the two ADCPs, which are suspended from the vessel.

During cable lays, the Kaimalino will station keep behind the slowly moving cable laying vessel. The Kaimalino's Master is responsible for keeping a safe distance from the Flexservice.

An acoustic transponder on the lower ADCP frame will be monitored for position and compared to the position of the transponders attached to the cable being laid. The Kaimalino's Master will have a navigation monitor on the bridge, which will display the position of these transponders. The DAS operators will assist the Kaimalino's Master in interpreting the display such that the ADCP can be maneuvered as closely as safe and practical to the lower end of the descending cable. This will produce the most representative current profiles for use in the ICS computer solutions.

The DAS technicians onboard Kaimalino will monitor the depth of the lower ADCP and adjust it according to ocean depth. The objective will be to keep the ADCP package as low as possible in the water column, within instrument pressure limits, to get the maximum available information on current profiles in the lower end of the water column.

G. SUBMERSIBLE PISCES OPERATIONS

During the At-Sea Test, the cable will be repeatedly laid along two portions of the cable path across the Alenuihaha Channel. The operation could last up to 10 days. A maximum of 10 cable lays are expected which would involve 10 separate Pisces V dives of maximum duration.

During each of these cable lays, the Pisces V is required to dive on the cable during the lay, but stay at least 1 km aft of the cable lay vessel, to verify cable bottom location (with transponder on the Pisces), observe the cable condition on the bottom, and measure the tension at specific locations on the cable.

The Pisces will be required to find the cable on the seabed and follow the cable closely while it is acoustically tracked by the Acoustic NAV System on Flexservice 3. In areas where glass ball transponders are attached to the cable, the Pisces can leave the cable to maintain a safe distance from the transponders. The HDWC observer will record times when the Pisces is "on" the cable and when it is away from the cable. The observer will also select locations where cable tension measurements are to be taken by Pisces. After recovery of the submarine, the observer's data will be radio communicated to the cable lay vessel.

At the beginning of each of the Pisces V dives, the Pisces V will be directed by the operator of the Fleet Management Computer (FMCS) to a specific location on the bottom to begin the reconnaissance. This x,y bottom target location will be punched into the FMCS and displayed when required. The ADCP QA computer system on Kaimalino will calculate the surface launch coordinates for Pisces in order to descend on the bottom target location, based on the best available ADCP current profile data and the Pisces' estimated rate of descent. This x,y surface launch location will be verbally provided to the FMCS via radio from the SSP Kaimalino to the FMCS operator, and this position will be punched into the FMCS and displayed as required.

The cable lays can be on a 30 to 40 hour cycle, thereby requiring a short turn-around time for the _Pisces_ and possible launch or recovery operations at night. If necessary, it will be possible to avoid night recoveries by having the submersible remain on the bottom until daylight.

The FMCS will also coordinate _Pisces_ Navigation during re-surfacing and whenever the cable ship commences cable recovery.

H. <u>CABLE RETRIEVAL - FLEXSERVICE 3</u>

In order to gain the maximum benefit from the time scheduled at sea, the cable recovery should be performed without the participation of the ICS. In this way, control personnel are free to check data, such as drag coefficient or free span length, from previous lays and from *Pisces* dives. They may adjust control parameters if needed, or change some laying procedures, such as the number or the location of transponders in order to place the cable more accurately during the next lay. A recovery operation without the guidance of the control system will require a procedure independent of currents. It is planned to recover the cable at a high bottom tension in order to minimize current effects on the suspended cable.

(The following assumes that the ICS will not guide the operation). The Test Director will check that all systems are ready. In particular he will check the *Pisces V* location (if in water) and that the ICS has provided for the recovery procedure, a printout which will include:

- Intermediate way points and ship speed for the DP operator.

- Corresponding cable speeds, total cable payout and cable length marks for each way point.

- Anticipated top cable tension and the cable length to be recovered to increase the bottom tension.

- Transponder locations.

- Warnings (if any).

The Test Director will then authorize the Bridge to commence the recovery.

TRANSPONDER RECOVERY

The deck supervisor will call to the bridge for "stop for transponder" as soon as the transponder is surfacing. He will then instruct the Tensioner Operator to recover cable slowly until the transponder clamp is onboard and stop the Tensioner. When the clamp is removed, he will authorize the Bridge to resume the recovery.

On all testlays but the last, the cable recovery will be stopped with at least 300 m. of cable still over the side. The Flexservice will then proceed to the next cable lay start point.

The baffle (acoustic transponder) will be raised out of the water each time the Flexservice completes a lay-recovery cycle and before transit to the next site.

CABLE RECOVERY - TEST DIRECTOR CHECK LIST FORM

1. BEFORE BEGINNING RECOVERY: OPERATIONS ORDER

Lay Number: ______________________________

Planned Track: ______________________________

Seabed Starting x,y of recovery ______________________________

Est. Recovery Start Time & Date: ______________________________

Est. Pisces Location

At Recovery Start Time: ______________________________

Weather Forecast: ______________________________

Systems Out (if any): ______________________________

Special Conditions (if any): ______________________________

2. SYSTEMS READY CHECKOFF (RADIO):

		PERSON ON DUTY
ADCP	BY	______________
ANS	BY	______________
COFLEXIP DECK LEADER (INCLUDING XPDR LIST)	BY	______________
COFLEXIP TENS. OPR.	BY	______________
COFLEXIP DP OPR.	BY	______________
DAS/SURF NAV	BY	______________
KAIMALINO BRIDGE (ON STATION & READY)	BY	______________
FLEXSERVICE BRIDGE (ON DP AT STATION & READY)	BY	______________
ICS	BY	______________

I. ADDITIONAL TESTS

The additional tests outlined below are options that will be performed, time permitting, in order to better understand the performance and capability of the Integrated Control System.

One of these tests is to intentionally lay the cable out of the desired accuracy (both in position and bottom tension). The ICS operator will stop the laying, recover, and relay the cable correctly. It could be necessary to perform this operation during other lays (due to a variety of problems that can be encountered during a cable lay), but at least one such test should be planned and performed.

Another test is to perform a laying operation varying ship speed and cable payout in order to introduce large dynamic inputs into the suspended cable. The capability of the ICS to control such dynamics will be observed.

A complete recovery guided by the ICS would check the ICS capability to maintain bottom tensions different that those used during laying. The data obtained during this recovery, compared to that performed without ICS guidance, are useful from a cable repair procedure point of view. Note that this could become the normal recovery procedure in the event that large current variations occur during these operations.

Depending upon time available, extra transponders may be attached to the cable at the beginning or at the end of a laying operation. Starting from a steady configuration, calculated by the ICS and verified acoustically with transponders, the ship can be moved fore and aft as directed by the ICS, thus varying the catenary shape and the cable bottom tension. The solution for these new configurations, generated by the ICS, can be checked against transponder positions. Analysis of these data will provide information relevant to the ICS capability and accuracy in computing the shape and bottom tension of the suspended cable.

J. CABLE EMERGENCY CUT AND ABANDON PROCEDURE

OBJECTIVE:

This procedure is provided for use in the event of an unplanned need to cut the cable and drop the cut end over the side. This procedure would be used at the direction of the Test Director.

PROCEDURE:

- Decision by Coflexip Master (in case of vessel safety) or Test Director (in case cable is caught on bottom or for other reasons) to cut and abandon the cable.

- All Dillingham and subcontractor personnel will shut down their equipment, and leave the stern area before the cable is cut.

- The Coflexip deck crew will apply cable seizings at 2 places on either side of the location to be cut.

- The cable will be cut using a remotely-actuated hydraulic shear device secured to the deck of Flexservice 3.

- The cut end of the cable will be let go to run overboard through the sheave.

- The on-board end of the cable will be held in the tensioner.

V. OPERATIONS PLANNING AND DOCUMENTATION

A. CABLE LAY CHECKLISTS

Figure VA.1, Cable Lay - Test Director Check List Form and Figure VA.2, Cable Recovery - Test Director Form, will be completed by the Test director or his designated representative prior to initiating a cable laying or retrieval operation.

Figure VA.1

A. CABLE LAY - TEST DIRECTOR CHECK LIST FORM

1. BEFORE BEGINNING LAY: OPERATIONS ORDER

Lay Number: ______________________________

Planned Track: ______________________________

Seabed Starting x,y ______________________________

Est. Lay Start Time & Date: ______________________________

Est. Pisces Location

At Lay Start Time: ______________________________

Weather Forecast: ______________________________

Systems Out (if any): ______________________________

Special Conditions (if any): ______________________________

2. SYSTEMS READY CHECKOFF (RADIO):

		PERSON ON DUTY
ADCP	BY	______________
ANS	BY	______________
COFLEXIP DECK LEADER (INCLUDING XPDR LIST)	BY	______________
COFLEXIP TENS. OPR.	BY	______________
COFLEXIP DP OPR.	BY	______________
DAS/SURF NAV	BY	______________
KAIMALINO BRIDGE (ON STATION & READY)	BY	______________
FLEXSERVICE BRIDGE (ON DP AT STATION & READY)	BY	______________
ICS	BY	______________

Figure VA.2

CABLE RECOVERY - TEST DIRECTOR CHECK LIST FORM

1. BEFORE BEGINNING RECOVERY: OPERATIONS ORDER

Lay Number: ______________________________

Planned Track: ______________________________

Seabed Starting x,y of recovery ______________________________

Est. Recovery Start Time & Date: ______________________________

Est. Pisces Location

At Recovery Start Time: ______________________________

Weather Forecast: ______________________________

Systems Out (if any): ______________________________

Special Conditions (if any): ______________________________

2. SYSTEMS READY CHECKOFF (RADIO):

		PERSON ON DUTY
ADCP	BY	______________
ANS	BY	______________
COFLEXIP DECK LEADER (INCLUDING XPDR LIST)	BY	______________
COFLEXIP TENS. OPR.	BY	______________
COFLEXIP DP OPR.	BY	______________
DAS/SURF NAV	BY	______________
KAIMALINO BRIDGE (ON STATION & READY)	BY	______________
FLEXSERVICE BRIDGE (ON DP AT STATION & READY)	BY	______________
ICS	BY	______________

B. WATCHBILL

The HDWCP project personnel will coordinate with the watch rotation of the Flexservice 3 technical staff. Project members will follow 12 hour cycles of six hours shift work followed by six hours of rest. The shifts will rotate at 0000 hours, 0600 hours, 1200 hours and 1800 hours. On-coming shift workers will eat before reporting for work , and off-going workers will eat after their shift. The shift assignments are on Table VB.1.

Table VB.1

AT-SEA TEST WATCHBILL - KEY PERSONNEL

	SHIFT 1	SHIFT 2
FLEXSERVICE 3		
TEST DIRECTOR (DILLINGHAM)	FRANK McHALE	KEN CARVALHO
ICS SUPERVISOR (MAKAI)	JOE VAN RYZIN	ANDREW RESNICK
ICS STA. 1	JOSE ANDRES	REX MIYASHIRO
ICS STA. 2	DALE JENSEN	STEVE JEFFRIES
ANS OPERATOR (OCEANO)	ALEX MALCOLM	JIM LOCKHART
VESSEL MASTER (COFLEXIP)	SVEN JENSEN	N/A
VESSEL MATE (COFLEXIP)	N/A	REX RUSSELL
OFFSHORE MANAGER (COFLEXIP)	GUY JAHANT	N/A
OFFSHORE ENGINEER (COFLEXIP)	CHRIS PREAUX	DIDIER PETIT
DAS/FMCS OPERATORS (NODA)	FRED JANCEWICZ	BENSON KIM
DECK OPERATIONS (NODA)	BOB MITIGUY	PAUL HEUCHLING
KAIMALINO		
ASST. TEST DIRECTOR (DILLINGHAM)	DAVE O'DAY	N/A
ADCP OPERATOR (HAMILTON)	BOB HAMILTON	MIKE VOGEL
DAS SUPERVISOR (NODA)	ED NODA	N/A
DAS & SURFACE NAV OPR (NODA)	BRIAN ISHII	LARRY BROWER
WINCH OPERATORS (NODA)	FRED CASCIANO	ALVIN McADAMS
VESSEL MASTER (NOSC)	CLARY GUTZEIT	
VESSEL FIRSTMATE (NOSC)	N/A	GARY ANDERSON
KILA/PISCES		
KILA MASTER (HURL)	JIM BATES	N/A
DIVE MASTER (HURL)	TERRY KERBY	N/A
DIVE OBSERVER (MAKAI)	RICK LANEY	N/A

C. PISCES DIVE PLAN

The Test Director will inform the HURL Personnel of the next desired Pisces dive time. This request will be made as far in advance as possible. Subsequently, the Test Director will confirm:

- o Dive Schedule
- o Recommended x,y position for launch
- o Desired x,y starting position on bottom
- o Planned x,y of tension measurements on laid cable
- o Direction of dive (downhill/uphill)
- o Expected recovery time and x,y

The surface position for deployment of the submersible is provided by the DAS using the actual current profile. Once in position, the Kila will call the Test Director, who in turn will ask the DAS to check the surface launch position based on actual current data. The Test Director will then confirm or change the Pisces position and authorize the dive.

The position of the Kila will be observed every 140 seconds by the Oceano ANS system and recorded by the DAS. The DAS will display a warning message on the fleet management computer if the ANS loses signal from Pisces. In addition, the ANS operator should advise the Test Director if the Pisces location data are not being received.

During the dive, the Fleet Management Computer Operator (FMCO) will report the sub's x,y,z coordinates to the support vessel Kila every 30 minutes. This will be done 15 minutes before the routine 30 minute check between the Pisces and the Kila.
If the Pisces approaches closer than 1 km to the Flexservice 3, a warning message will appear in the Fleet Management Computer display at the Test Director's workstation.

An observer from Makai will be on board the submarine during each dive. This observer will maintain a manual and/or audio tape log that will enable later correlation with ANS data recorded in the DAS system.

The MOE observer's log on Pisces will contain the following at a minimum (use PST):

- o Time & date of starting dive
- o Time on bottom
- o Time when "on" cable for first time
- o Periodic observations when "on" cable
- o Time when over a 100-meter paint mark on cable
- o Time when avoiding/going around a cable transponder
- o Time when marking a special event and "on" cable -suchas tension measurement, span observation, special observation
- o Time when raising off bottom to get a better acoustic fix if necessary

The observer should consider that a position within 3 meters horizontally is "on" the cable.

The Pisces will run her tension and free span measuring program as an independent activity, with two exceptions:

- o The Test Director will inform the Kila if the ANS loses the acoustic location of the sub.

- o If the Pisces needs a good fix, she will inform the Kila which in turn will ask the Test Director. If the ANS is unable to determine the Pisces location, the Pisces V will be asked to raise herself in 10 m intervals until clearly seen by the ANS.

During the last 15 minutes of recovery, the Test Director will provide the <u>Kila</u> with the sub's position (x,y,z) every 2 minutes.

Representative communications are provided in summary form in Table VC.1.

Table VC.1

PISCES DIVE COMM PROTOCOL

Test Director to all stations:
Operations order

Test Director to Pisces:
Give advance notice to request dive at hhmm

Test Director to Pisces:
Confirm dive schedule, starting x,y bottom position, recommended x,y surface start location, x,y of special locations to measure bottom tension, direction of dive (downhill/uphill), synchronize clocks.

Pisces to Test Director:
Request DAS to check surface launch position

Test Director to DAS:
Request check on surface launch position

Test Director to Pisces:
Confirm or change Pisces launch position and authorize dive

Test Director to Kila:
Give subs's x,y coordinates every 30 minutes

Test Director to Kila:
To advise if the ANS loses the sub

Pisces to Kila to Test Director, if Pisces requests a fix

Test Director to Kila to Pisces:
If Pisces needs to raise herself to be in ANS visibility

Test Director to Kila:

Giving the sub's x,y position every 2 minutes during the last 15 minutes of recovery

D. HELICOPTER TRANSPORT PLAN

The use of a helicopter is envisioned for two purposes; medical evacuation of personnel and rapid delivery of materials and technical support personnel necessitated by equipment malfunctions. The Flexservice 3 is equipped with a sixty-two foot diameter helipad which can accommodate a BELL 212, PUMA, or other similar helicopter. Since the HDWCP At-Sea Test fleet will be located in the middle of the Alenuihaha Channel, the use of helicopters will be much more expedient than returning to port.

MEDICAL EVACUATION

In cases of medical emergency, the U.S. Coast Guard's search and rescue office will be contacted using radio communication on marine band channel 19. The following information must be provided to the Coast Guard:

- o Nature of distress/seriousness of injury.
- o Name/location/description of vessel with the injured person.
- o Injured person's name/social security number/home address.

All cable laying operations will be suspended until the medical evacuation is complete. At that time the At-Sea Test Director will decide whether to continue the operations with available personnel or to discontinue until a replacement arrives.

EQUIPMENT AIRLIFT

In cases of equipment malfunction and the need for servicing or delivery of repair parts onto one of the vessels, the Test Director will use the Marine Operator to contact Hawaiian Dredging's procurement department to locate and transport the needed materials to the island of Maui. The materials or technician shall be delivered to Maui Helicopter Service for air delivery to the Flexservice 3. While awaiting delivery, the test director shall seek other means of repair and make a decision regarding the continuation of the operations.

E. COMMUNICATIONS PLAN

The AST will be carried out on a 24-hour basis. The radio comm network contains four channels and will be in use at all times. This section is intended to describe the authorized conversations that should be heard on the primary communication channel (channel one). Unauthorized communications will be avoided in order that the primary network is free for emergency.

Start Laying: The Test Director will check that all systems are operative and ready. The Test Director will then authorize the ICS to commence the laying. With a general call, the ICS supervisor will advise when data will be provided to the DP and Tensioner operators within 30 seconds.

During Laying: The ICS supervisor will have priority and will be in communication with all stations, with operational traffic to the Coflexip Manager for messages to DP, Tensioner, and Bridge, and technical discussions with DAS, ANS and ADCP.

End of Laying: The ICS supervisor will instruct the DP and Tensioner operator to stop. This will be done via software. The ICS supervisor will inform all stations (via radio) that this is the end of the laying.

Stop Laying: The instruction to stop the cable laying has the same protocol as an end of lay stop except for the reason. (e.g. cable bottom tension higher than required, cable touchdown point out of path, ADCP or ANS breakdown, etc.). While other stations may recommend a "stop lay", only the ICS supervisor is authorized to issue the instruction.

Emergency Stop (during laying or recovery): Any station can call for an emergency stop using the phrase "Emergency Stop" on the common channel. Emergency stop will be used only in the event of a major equipment failure, a condition hazardous to people, or an injury.

a) During Laying

- ICS supervisor: first the Tensioner operator and then the bridge will acknowledge the receipt of the command by repeating the instruction "All Stop to the bridge (or tensioner)".

  "ICS to Tensioner - Emergency Stop" (Acknowledge)
  "ICS to DP - Emergency Stop" (Acknowledge)

b) During Laying and Recovery

- Deck supervisor (during transponder attachment): first the CHE operator and then the bridge will acknowledge the receipt of the command by repeating the instruction "All Stop to the bridge (or tensioner)". The ICS will not acknowledge via radio this request.

  "Deck Engineer to Tensioner - Emergency Stop" (Acknowledge)
  "Deck Engineer to DP - Emergency Stop" (Acknowledge)

- Bridge: only the CHE operator will acknowledge receipt.

- CHE Operator: only the bridge will acknowledge receipt.

Heading Change: The Bridge will warn the ICS (5 minutes warning) that a change in heading is needed. The agreed rate is 2 deg/min. The ICS, when ready, will authorize the heading change. The Bridge will notify the start and the completion of each step.

Pisces V Dive: The Test Director will inform the Pisces V (Kila) of the next desired dive time and location. During launch, the Pisces (Kila) will reconfirm the starting location with DAS by communicating with the Test Director. During the dive the Test Director will pass ANS position information to the Kila every 30 minutes, and every 2 minutes during the last 15 minutes of submersible recovery.

Start Cable Recovery: The Test Director will authorize the Bridge to commence the recovery. The Bridge will ask the CHE operator to recover the cable.

End of Recovery: The Bridge will instruct the CHE operator to stop the haul-in.

Transponder Recovery: The deck supervisor will call for "stop for transponder" as soon as the transponder is surfacing. He will then instruct the CHE operator to recover cable slowly until the transponder clamp is onboard and stop the CHE. When the clamp is removed, he will authorize the Bridge to restart the recovery.

Equipment Breakdown: In case of equipment breakdown, the person in charge of that equipment will call the person stated below on the common channel, shifting to a second one if a long conversation is foreseen.

a) Bridge/ICS/CHE:

- The Bridge will inform the ICS if they are using the backup radiopositioning system. Refer to Emergency Stop for other failures.

b) <u>DAS:</u>

- o Minor failure (not affecting ICS performance): For example, Wave Rider or accelerometer malfunctioning, the DAS operator will inform the Test Director.

- o Major failure (affecting ICS performance): The DAS operator (onboard the <u>FS 3</u> or the S/V) will inform the ICS supervisor who will confer with the Test Director to decide if the laying operation must be halted.

c) <u>ADCP:</u> The ADCP operator will inform the S/V manager who will in turn call the ICS supervisor.

d) <u>ANS:</u> The operator will call the ICS supervisor.

<u>Acoustic Module Approaching the Stern:</u> The Bridge will monitor the location of the ANS acoustic module (on the baffle) with the <u>FS3</u>'s SIMRAD HPR ultrashort baseline acoustic system. If the acoustic module approaches the stern of the <u>FS3</u>, the Bridge will inform the ANS operator and the deck supervisor.

F. WEATHER MONITORING PLAN

At-sea test operations will not be initiated in sea state conditions greater than SS4 (winds 14 to 17 knots, Average Wave Height 8 Ft). Operations will be halted if sea state conditions exceed SS5 (winds 27 to 40 knots, average wave height 12 feet). The following monitoring plan will be used to forecast the effect of weather on daily operations.

Weather Monitoring Schedule

Beginning three days prior to the arrival of the FS3 at Honolulu the following weather monitoring schedule will be implemented:

- o Weather at the testlay sites will be monitored daily via the Navy computer link. If reports indicate sea-state 3 or greater at the site, conditions in the Alenuihaha Channel will be ascertained from tug boats operating in the Channel.

- o During at-sea operations, VHF Marine Radio Weather Forecasts will be monitored and logged by each vessel every six hours.

Weather Forecast Sources

National Oceanic & Atmospheric Administration (NOAA) / National Weather Service:

1. Recorded Marine Forecast: 834-7674
2. Broadcast Marine Weather Forecasts:
   VHF-FM
   KBA-99
   162.55 MHz or 162.40 MHz

Navy Oceanographic Data Distribution System - U.S. Navy Fleet Numerical Oceanographic Center:

Direct computer link at the office of Edward K. Noda will provide 12, 24, 48 and 72 hour forecasts of:

- o Surface wind speed and direction.
- o Two dimensional wave spectra.
- o Significant wave height and primary & secondary wave direction and period.

G. SAFETY

Personnel safety has been a major consideration in the formulation of the At-Sea Test procedures. Many subtle planning factors, such as the separation distance between the _Pisces_ and the _Flexservice 3_, originate due to safety concerns.

Conventional safety planning has included proactive measures which attempt to avoid mishaps and reactive measures which seek to prepare remedies in the event of an accident. Proactive planning includes:

- Vessel safety inspections onboard the _SSP Kaimalino_ and Flexservice 3 by the American Bureau of Shipping Technical Services division.

- Requiring vessel operators to conduct safety briefings for boarding HWCP personnel. Figure VG.1 is a copy of Coflexip's safety information sheet handed out.

- An analysis of potential safety hazards and precautionary actions to avoid them. This analysis is summarized on Table VG.1.

Reactive safety planning includes:

- Establishment of the helicopter transport plan with provisions for medical evacuations.

- Establishment of instructions for the emergency stopping of cable laying operations in the communications plan.

M/v «FLEXSERVICE 3»
GRIMSTAD
NORWAY

YOUR CABIN NO. IS : STBD 5 ...
YOUR LIFEBOAT STATION IS : PORT OR ...
LIFEBOAT.

SAFETY INFORMATION

1: REPORT TO DUTY OFFICER IMMIDEATELY ON ARRIVAL FOR SAFETY BRIEFING

2: IN YOUR CABIN YOU WILL FIND ALARM INSTRUCTOINS, CHECK WHERE TO GO WHEN THE FIRE OR LIFEBOAT ALARM IS SOUNDED.

3: <u>LIFEBOAT ALARM</u>: CONTINOUS RINGING OF THE ALARMBELLS.
AND/[redacted] 7 SHORT AND 1 LONG BLAST WITH SHIPS SIREN.
<u>ACTION</u>:GO IMMIDEATELY TO YOUR LIFEBOAT STATION.
REPORT ON ARRIVAL, AND PUT ON A LIFEJACKET.
IF NEEDED SURVIVAL SUITS ARE STOWED NEAR THE LIFEBOAT STATIONS.

4: <u>FIREALARM</u>: INTERMITTENT RINGING OF THE ALARMBELLS.
<u>ACTION</u>: GO IMMIDEATELY TO FIRESTATION NO: 1,
PORT SIDE SHELTERDECK. REPORT ON ARRIVAL.

FOR YOUR OWN SAFETY

- STUDY THE SAFETY AND EMERGENCY PLANS DISPLAYED IN THE ACCOMMODATION
- HARD HATS AND SAFETY BOOTS MUST BE WORN IN WORKING AREAS ON DECK
- FOR MORE INFORMATION CONTACT DUTY OFFICER ON THE BRIDGE.

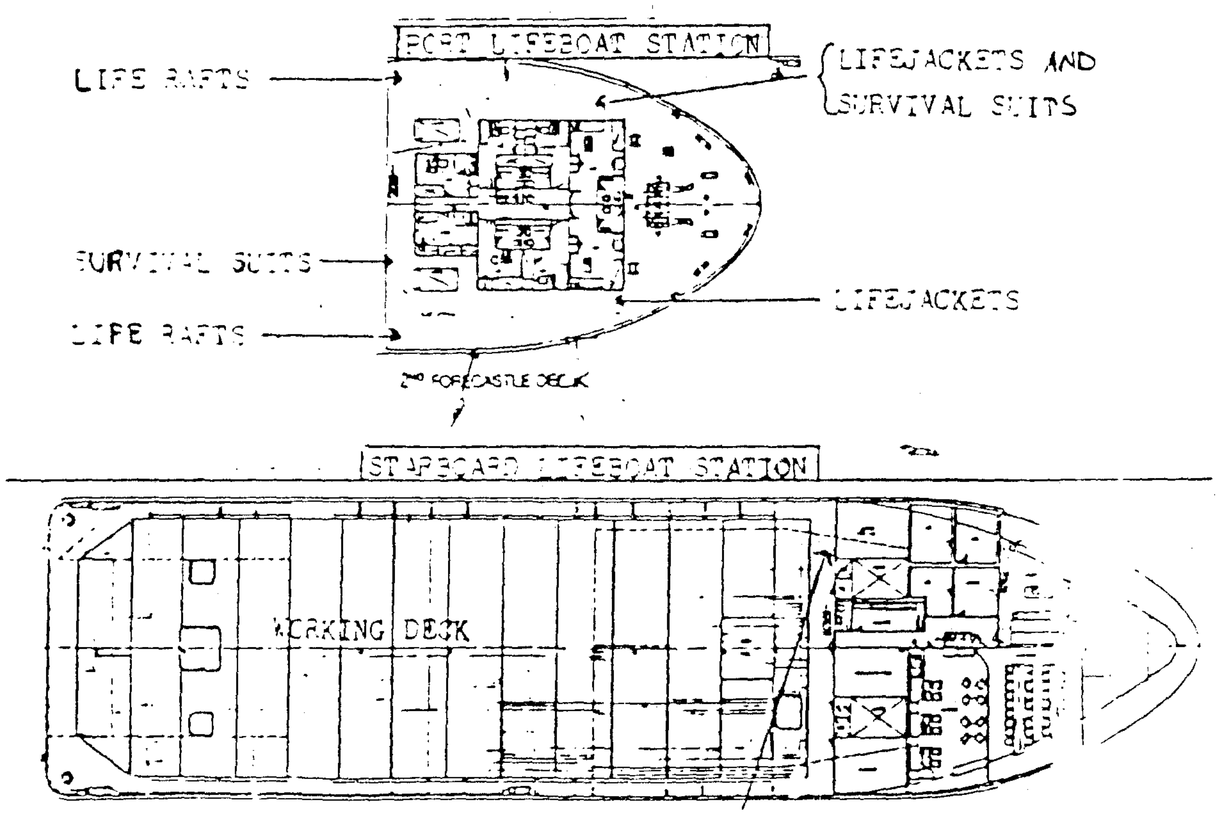


FIGURE VG.1

Table VG.1

HAWAIIAN DREDGING & CONSTRUCTION
HAWAII DEEP WATER CABLE PROGRAM
AT-SEA TEST OPERATION

HAZARDS ANALYSIS

POTENTIAL HAZARDS	PRECAUTIONARY ACTION
Tripping or Slipping on Deck	Maintain good housekeeping, deck lighting, clean up any oil spills.
Fire	Store hazardous material in a controlled area; know fire extinguisher locations, inspect for fuel leaks.
Novice Personnel	Qualified personnel only, buddy system.
Back Strain	Qualified personnel. Don't carry heavy objects when seas are rough.
Skin Burns	Sunscreen (Min. SPF 15)
Smashed Toes	Improper shoes, dropped shackles.
Smashed Fingers	Don't put fingers on door jamb.
Drowning	Life jackets will be worn when working near open deck edge. Ring buoy and raft available. Buddy System.
Abandon Ship	Safety briefing by Captain at start of voyage. Practice (simulate) release of life rafts, EPIRB, ring buoys. What if they are blown away from vessel?
Damage to Crane	Use qualified operator.
Liftcrane Failure	Qualified personnel, equipment checkout, load/radius limits.

Wire Rope Dangers	Never stand in bight of line; keep "out of line" and away from line under tension; wear gloves when handling wire rope.
Electric Shock	Cut off, check, post signs when deactivating a work area.

(Modern Towing - Captain John Blank)

SAFETY IS THE NAME OF THE GAME

SAFETY CONSCIOUSNESS SAVES LIVES

THE OCEAN HAS NO COMPASSION

H. CONTINGENCY PLAN

All major problems within the Integrated Control System as well as the Data Acquisition Systems (including current profiler and Acoustic Navigation System) will result in a stop of the cable laying.

Laying has to be stopped also in the event of a power failure in the tensioners because the machine will hold the braking load without paying out cable. In this case, the ship has to be quickly instructed to stop and (depending on the top cable tension), may be directed slightly backward to reduce such top tension.

The loss of a thruster unit has very low probability. The Flexservice 3 has redundant thruster systems and can maintain position with seas and winds which are much greater than the conditions expected during this project.

Loss of the signal of the radiopositioning systems, (loss here has the meaning that the DP ignores the signals due to great spread in readings) or a major failure in the DP itself. In this case the ship can keep position using the joy-stick helped by being somewhat "moored" by the cable.

It can therefore be seen that the primary contingency operation will consist of stopping the lay (or recovery). The magnitude of the problem and the weather forecast will dictate the solution to the problem and this will lead to continuing the operation or starting a cable recovery.

DELAYS

1. Delays of one day or less:

   a. Preconditions

1. A non-catastrophic problem has occurred.

2. The problem can be corrected by replacing a broken part.

b. Notification

1. The affected Subsystem Manager will notify the At-Sea-Test Director of the problem; explain its nature; what is required to fix it; and the estimated delay time.

2. The At-Sea-Test Director will advise RMP and HECO.

c. On-Site Action

1. Site personnel will take whatever action is necessary to keep the situation from deteriorating further and effect repairs using on-board replacement parts.

d. Off-Site Action

1. Arrange for either spare parts or additional manpower to be sent to the vessel.

2. Equipment breakdown which requires return to Honolulu:

a. Preconditions

1. A major problem has occurred.
2. The problem cannot be corrected without returning to Honolulu.

b. Notification

1. The affected system operator will notify the At-Sea-Test Director of the problem; explain its nature; and recommended action.

2. The At-Sea-Test Director will advise RMP & HECO.

c. On-Site Action

1. Secure from operations and return to Honolulu.

d. Off-Site Action

1. Make berthing and repair arrangements.

3. Vessel propulsion failure

a. Preconditions

1. Main engine failure which cannot be repaired at sea.

b. Notification

1. The Offshore Manager will notify the At-Sea-Test Director of the problem.
2. The At-Sea-Test Director will advise RMP and HECO.

c. On-Site Action

1. Recover all equipment.

d. Off-Site Action

1. Review situation with Coflexip Houston.

I. TRAINING PLAN

The majority of training for the At-Sea Test program was conducted during the Shakedown cruise. Training will continue under the following arrangements:

- Training of ICS computer operators will be a continuous process during the one month period before the arrival of the cable ship. Operators will continuously run computer simulations of the lay, including at least one real-time simulation on a 24-hour basis. The actual lays are expected to take approximately 18 hours, and this will give the operators the necessary experience as well as shake down the equipment.

- Training of the DAS, SURFACE NAV, ADCP, AND ANS Operators has been accomplished and integrated through the exercise of all these systems during the Shakedown Cruise. Any discrepancies or areas needing smoothing or improved coordination, determined through experience on the Shakedown Cruise, will be corrected prior to the At-Sea Test.

- Crew Training for the Pisces and its Support Vessel KILA is not required for operational purposes as the submersible and its support ship will be following their standard operating procedures. Training of the HDWC project observer who will be aboard the submersible will be carried out by personal briefings at the Makai office. Topics to be covered include items to be observed and logged, communications to be coordinated with the Test Director on the cable ship, and project priorities. Briefings for the submersible and Kila personnel, in order to integrate their efforts into the HDWC overall exercise, will be carried out at Dillingham with the HURL and Makai personnel, in advance of the cable ship arrival.

- <u>Training for integration of the cable ship and all other systems</u> will take place in two phases. In the first phase, the key Coflexip personnel will be briefed during the Dockside Acceptance Test scheduled to be held in Houston during the week of September 18, 1989. In the second phase, a briefing for all key project personnel will be held after the cable ship's arrival at Honolulu, during mobilization at dockside, and prior to departure for the Honolulu Sea Trials. Operations during the Sea Trials will constitute additional training.

J. OPERATIONAL COST CONTAINMENT PLAN

Dillingham Construction is bound by the "limitation of costs" clause documented previously. The following plan will be used by the Dillingham cost engineer to monitor and control cost during the At-Sea Test.

Prior to the At-Sea Test, the total cost-to-date for the project will be updated and used to identify the funds remaining for the project. The budgeted costs for post-test demobilization, report writing, administration, etc. will be subtracted from the funds available which equals the funds available for the At-Sea Test.

The budgeted costs associated with the At-Sea Test will then be segregated to fixed (unavoidable) and variable (avoidable) costs. Fixed costs include monthly equipment leases which will not change if the At-Sea Test duration is decreased. The monthly renewal date of the equipment will be identified to ensure that the costs do not increase in the event of a longer duration of the At-Sea Test.

Variable costs include daily changes for personnel and equipment which will fluctuate based upon the At-Sea Test duration. Examples include the Flexservice 3 and other vessel daily charter rates, and daily personnel charges for the subcontractor such as Makai Ocean Engineering and Oceano. Budgeted variable costs will be totalled on a "per day" basis.

Fixed costs will be subtracted from the total funds available for the At-Sea Test to identify the portion of funds available for variable costs. The funds available for variable costs will be divided by the budgeted daily variable cost resulting in the number of operational days for which funds are available. This number will be truncated. For example, 10.3 days becomes 10 days.

Refer to the attached table for a simplified budget calculation worksheet.

The cost engineer will reviews all fixed, variable, and newly incurred cost on a daily basis and report his findings to the Test Director at 1300 hours each day. The cost engineer wil advise the Test Director if the excess funding for contigencies is less than $10,000.

AT-SEA TEST BUDGET CALCULATION WORKSHEET

1.	Total funds available for the At-Sea Test Project	________
2.	Minus: Project Cost-to-Date	(________)
3.	Minus: Budget Post-Test Cost Items	(________)
4.	Fund available for the At-Sea Test	________
5.	Minus: At-Sea Test Fixed Costs	(________)
6.	Funds available for the At-Sea Test variable costs	________
7.	Budget variable costs	________
8.	Operational days authorized (item 6/item 7) Truncated to integer value	________
9.	Estimated variable cost (item 7 item 8)	________

BUDGET SUMMARY

A.	Total fund available (item 1)	________
B.	Minus total estimated costs (items 2+3+5+9)	(________)
C.	Excess funding for contingencies	________

VI. OPERATIONS CONCLUSION

The conclusion of the At-Sea test operations may be determined by several factors. These include successful completion of the objectives, nonavailablity of funds to continue operations, catastrophic equipment failure, or if the contracted time period is exceeded for the Flexservice 3. Upon the conclusion of activities, all relevant data will be collected for use in the analysis and report preparation.

A. SUCCESSFUL COMPLETION OF OBJECTIVES

The criteria for success is described in the introduction of this document. Once one successful lay is performed at each test site, the At-Seas Test objectives will be met and the operations may be concluded.

Additional laying cycles may be performed to gather additional data for testing the performance and capabilities of the Integrated Control System and for better evaluation of the capabilities of the systems and equipment for laying cable in the channel. The benefits of additional laying cycles versus the associated costs will be evaluated by the At-Sea Test director prior to authorizing additional lays.

B. DEBRIEFING AND DATA COLLECTION

Immediately following the demobilization of equipment from the At-Sea Test, the At-Sea Test Director will assemble all key project personnel to discuss the operations. Attendees shall include:

Hawaiian Dredging:	Frank McHale
	Dave O'Day
	Ken Carvalho

Coflexip:	Guy Jahant Offshore Engineers
Makai Ocean Eng.:	Joe Van Ryzin Andrew Resnick
Ed Noda & Assoc.:	Ed Noda
Evans-Hamilton:	Bob Hamilton Mike Vogel
Oceano Instruments:	Jim Lockhart Alex Malcolm
HECO Consultant:	Paul Walsh

The objective of the debriefing will be to identify any post processing work required to clarify the results of the operation, to identify the data needed by the company(s) performing the post processing, and to establish a timetable for transmitting the data, completing the work, and writing the At-Sea Test Report.

Appendix 1

DESCRIPTION OF MAJOR SYSTEMS AND WORK PLATFORMS

A. Flexservice 3

M/V Flexservice 3 (FS3) is the vessel that will lay the test cable. Her overall length is 83 meters with a breadth of 20 meters. She is equipped with a Dynamic Positioning (DP) system consisting of a Kongsberg Albatross 503 system with Syledis radio location.

Two Microfix systems will be provided on the vessel as the primary independent surface navigation system. They will be connected to the DP system through the ship computer. As Cable Handling Equipment (CHE) the vessel will use a powered storage reel and tensioner coupled with appropriate sensors to monitor cable speed, tension and length.

M/V Flexservice 3 (FS3) is the third in a series of flexible pipe-cable laying vessels owned by Ugland Management Co. A/S & Flexservice N/V and operated by Coflexip, a French flexible pipe manufacturing and cable laying firm. Their American subsidiary, Coflexip & Services, Inc. is located in Houston, Texas.

FS3 is a dynamically positioned vessel especially designed and built to perform a wide range of offshore services, particularly in deep waters and difficult sea conditions. FS3 is 83.2 m (273 ft) long and has a molded breadth of 19.8 (65 ft). The vessel is powered by two 2.8 MW (3700 BHP) main engines coupled to twin variable pitch propellers and four tunnel thrusters, two bow and two stern, for fully redundant positioning capability.
The main features of the FS3 as outfitted for the At-Sea Test are as follows:

- o A KONGSBERG ALBATROSS 503 Dynamic Positioning System. This is a computerized system which enables the vessel to be automatically controlled in both position and heading within ±2 m (6.6 ft). The computer is totally redundant, backed by a second identical computer which takes over immediately in

o the event of failure. A manual joystick control is available allowing backup control and bypassing of the computer if necessary.

- o Two TRICHENILLE/30T linear tensioners.

- o A 5.5 m (18.0 ft) diameter overboarding sheave and a TR7 integral cable drum winch which can store up to 200 tonnes of cable.

Figure 1A.1 shows profile and plan views of the vessel as arranged for the reduced scale at-sea test.

CABLE HANDLING EQUIPMENT

The cable handling equipment to be used for laying the surrogate cable on the FS3 is comprised of the following items:

OVERBOARDING DEVICE

A 5.5 m (18.0 ft) diameter sheave mounted on the stern of the FS3. This sheave is designed to withstand a maximum load of 50 t. It can accommodate power cable up to 160 mm (6.5 in) in diameter.

TENSIONING MACHINE

Cable tension will be handled by two Trichenille/30 T, three belt linear tensioners in series. These machines are hydraulically operated and linked. Each tensioner is capable of providing up to 30 tonne tension. The tensioners can operate at speeds of 0-30 m/min (0-98 ft/min) at design load. The tensioners are normally

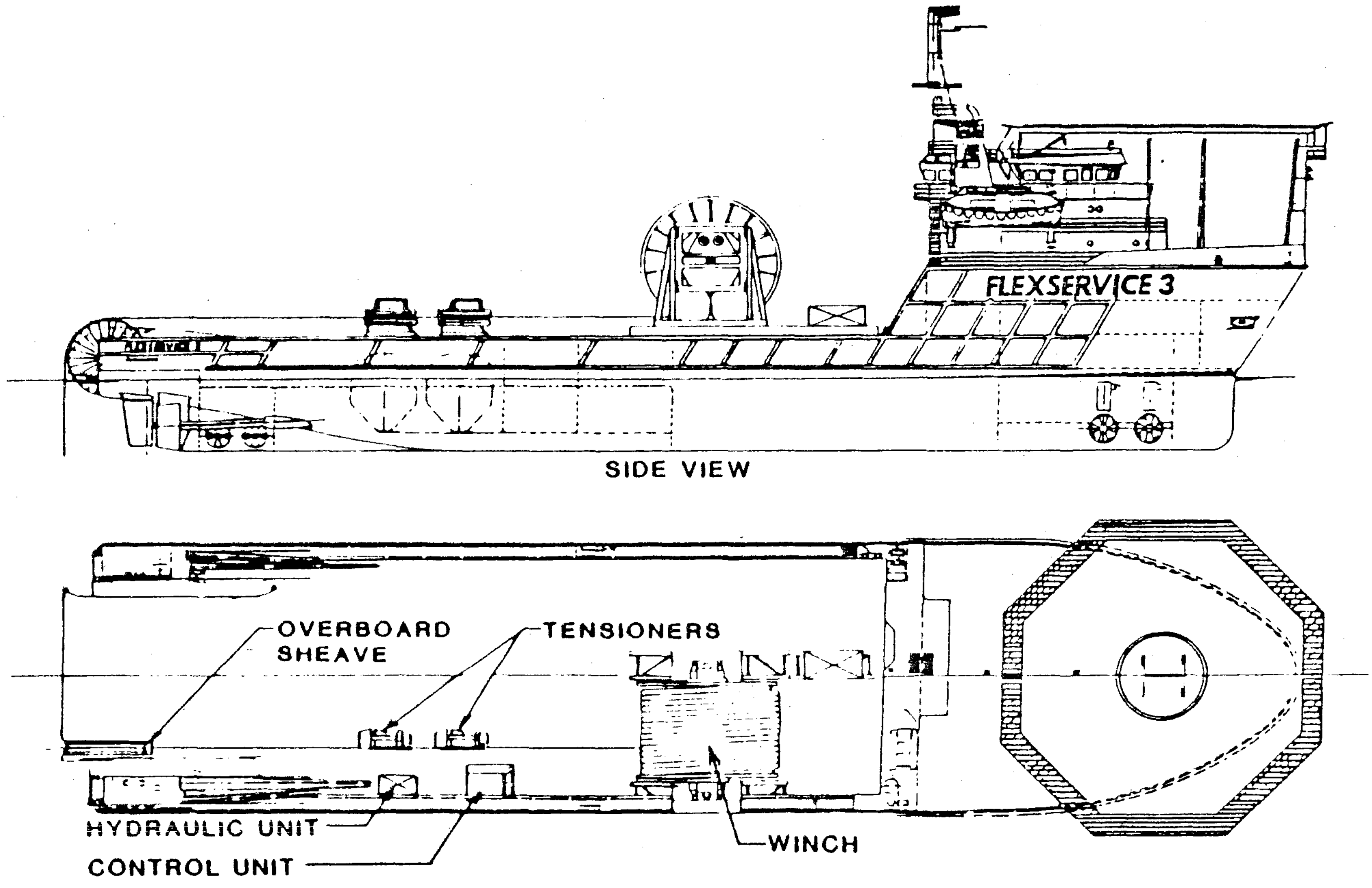


FIGURE 5.2 M/V FLEXSERVICE 3
(SOURCE COFLEXIP & SERVICES, INC.)

FIGURE 1A.1

operated as constant tension machines but can also be operated at a set speed.

The maximum static load retaining capability per unit is 45 t. This braking load can be held in the event of a loss in hydraulic power. Each tensioner has its own power pack to operate its hydraulic motors and clamping jack. The two hydraulic circuits are interconnected for speed synchronization and redundancy in the event of a power pack failure. Each power pack can operate both units at the maximum rated tension. The clamping jacks are adjusted for clamping forces on the cable ranging from 9 to 40 t/meter and fail safe. No undue pay out of cable occurs in the case of a power failure.

The tensioners are able to accommodate pipe or cable up to a diameter of 850 mm (33.5 in.). The gripper dimensions and pad material can be varied to suit the cable's exterior surface and diameter to achieve the maximum coefficient of friction between it and the cable's exterior surface.

Each unit is 4.4 m (14.5 ft) long, 4.4 m (14.5 ft) wide, 4.0 m (13 ft) high, and weighs 35 t.

The tensioners are instrumented to continuously provide the following information:

- Tension
- Cable payout speed
- Length of cable paid out
- Clamping force

Tension is measured via dynamometric axles in each tensioner. The response time of the device is negligible, allowing real time measurement of the variations in tension due to the motions of the vessel. Accuracy is within 5%.

Speed and length of cable paid out are measured by a sensor installed in each tensioner. Accuracy is on the order of 0.5% Clamping force is monitored through strain gauges mounted on the hydraulic jacks of the clamping system.

CABLE STORAGE DEVICE

The cable would be reeled on a TR7 winch, a hydraulic powered, integral drum winch which has the capability of storing up to 200 t of cable. It has a drum diameter of 4.4 m (14.5 ft), an outer flange diameter of 7.5 m (24.6 ft), and a flange to flange width of 5.4 m (17.8 ft). The cable would be spooled onto the winch through a level wind system.

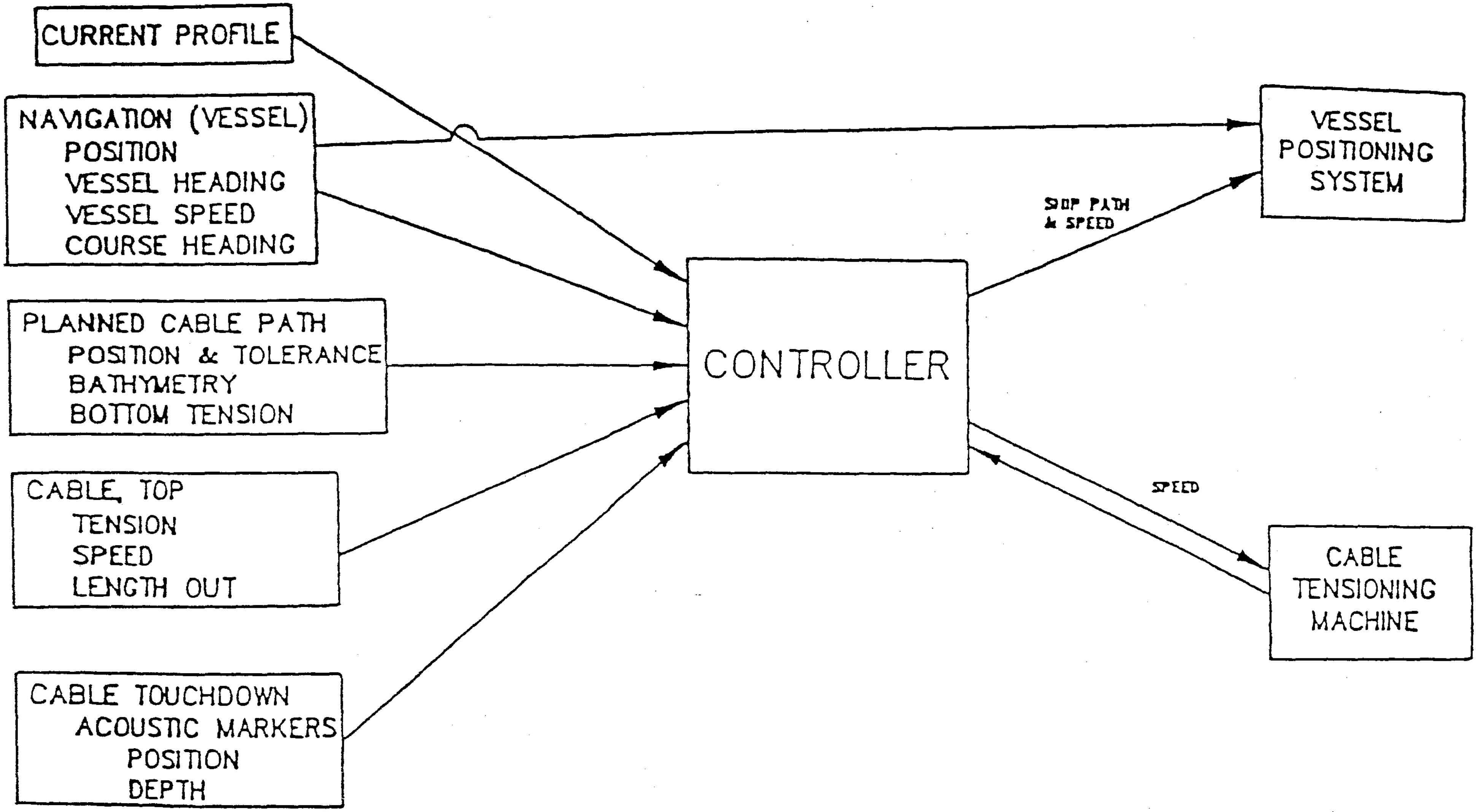
B. INTEGRATED CONTROL SYSTEM

GENERAL DESCRIPTION

The goal of the Integrated Control System is to accurately place and properly tension the cable on the ocean bottom. The system outputs instructions to the vessel to proceed along a particular course, and to the cable tensioner to pay out the cable at a specific speed. Corrections are continuously made to these instructions based on differences computed between the desired cable touchdown conditions and the actual touchdown conditions. In order to determine the actual touchdown conditions, the cable shape must be constantly computed based on incoming information such as ship position, currents, and cable transponder locations.

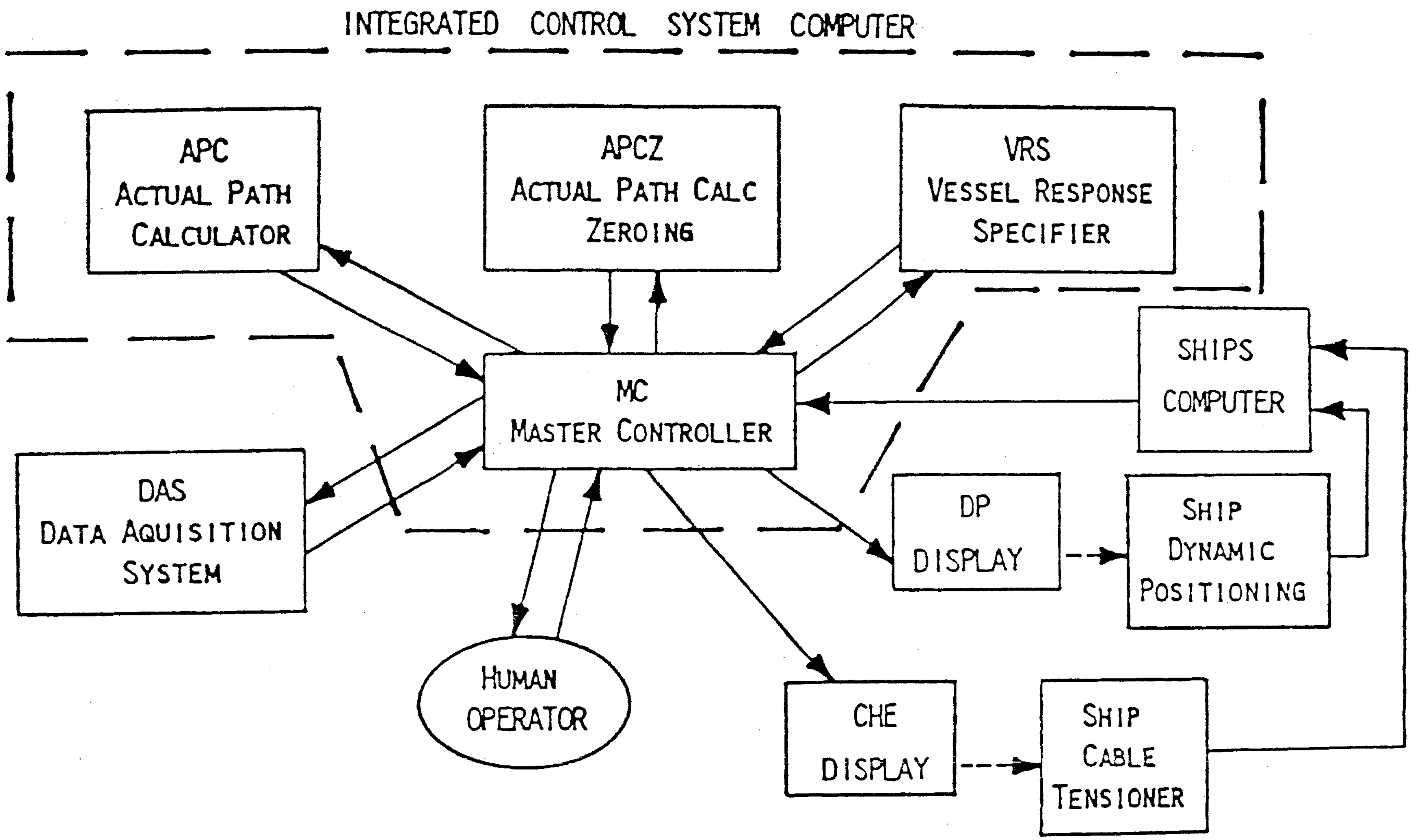
Much of the control loop is committed to these computations. To ensure accurate calculations the controller receives accurate measurements of the information shown on the left of Figure 1B.1. The ICS computer receives this information from the Data Acquisition System, the ship's computer and the ICS human operator. Output information to control the cable lay goes to the Dynamic Positioning operator's display and the Tensioner operator's display. Historical data go to the Data Acquisition System. This data flow is displayed on hardware/program interconnection Figure 1B.2.

Under most circumstances, accurate knowledge of the current profile, vessel navigation, cable payout, the planned path including bathymetry, and the history of the cable lay is adequate to determine a sufficiently accurate touchdown point and tension. Where very high tension or position accuracies are required, transponders will be added to the cable to reduce the computational error.



INPUTS/OUTPUTS TO INTEGRATED CONTROL SYSTEM

FIGURE 1B.1



HARDWARE/PROGRAM INTERCONNECTION

FIGURE 1B.2

CONTROL SYSTEM HARDWARE AND OPERATING SYSTEM

The hardware and operating system selected in the final design of the ICS is a HP 9000 Series 800 Model 835CHX with peripherals, shown in Figure 1B.3. The HP uses a Unix-V standard operating system and supports a Fortran 77 compiler, the language in which the programs have been developed.

The entire Integrated Control System will reside on the HP computer. All the numerical models and control programs will run as processes on the HP. All the displays will be on peripherals of the HP. This simplifies fabrication of the system, eliminating many problems of connection and communications protocol.

Shown in the figure is the At-Sea Test configuration of the HP. There will be both primary and backup systems for the At-Sea Test. The computers have identical System Processing Units (SPUs) with Local Area Network (LAN) and Multiplexer (MUX) hardware.

Connected to the SPU buss are the CHX and CH monitor subsystems. The CHX and CH are individual components that provide I/O control monitor, keyboard and mouse. Also connected to the SPU buss are the 304 Mb disk drives and the cartridge tape drive.

The MUX can connect to up to 6 RS232 devices. On the primary system this will include 3 terminals, the Flexservice 3's VAX computer, the DAS and a printer. The terminals will display commands to the DP and CHE operators and information on the ICS activity. The LANs are used to connect the 2 systems together providing a means of quickly updating either system. The LAN may also be used for connection to the DAS, if the MUX RS232 connection proves too slow.

The ICS operator will work on a single color graphics monitor in a windows environment. The windows environment will enable him to quickly check all the processes and perform his operations from

CS EQUIPMENT SCHEMATIC

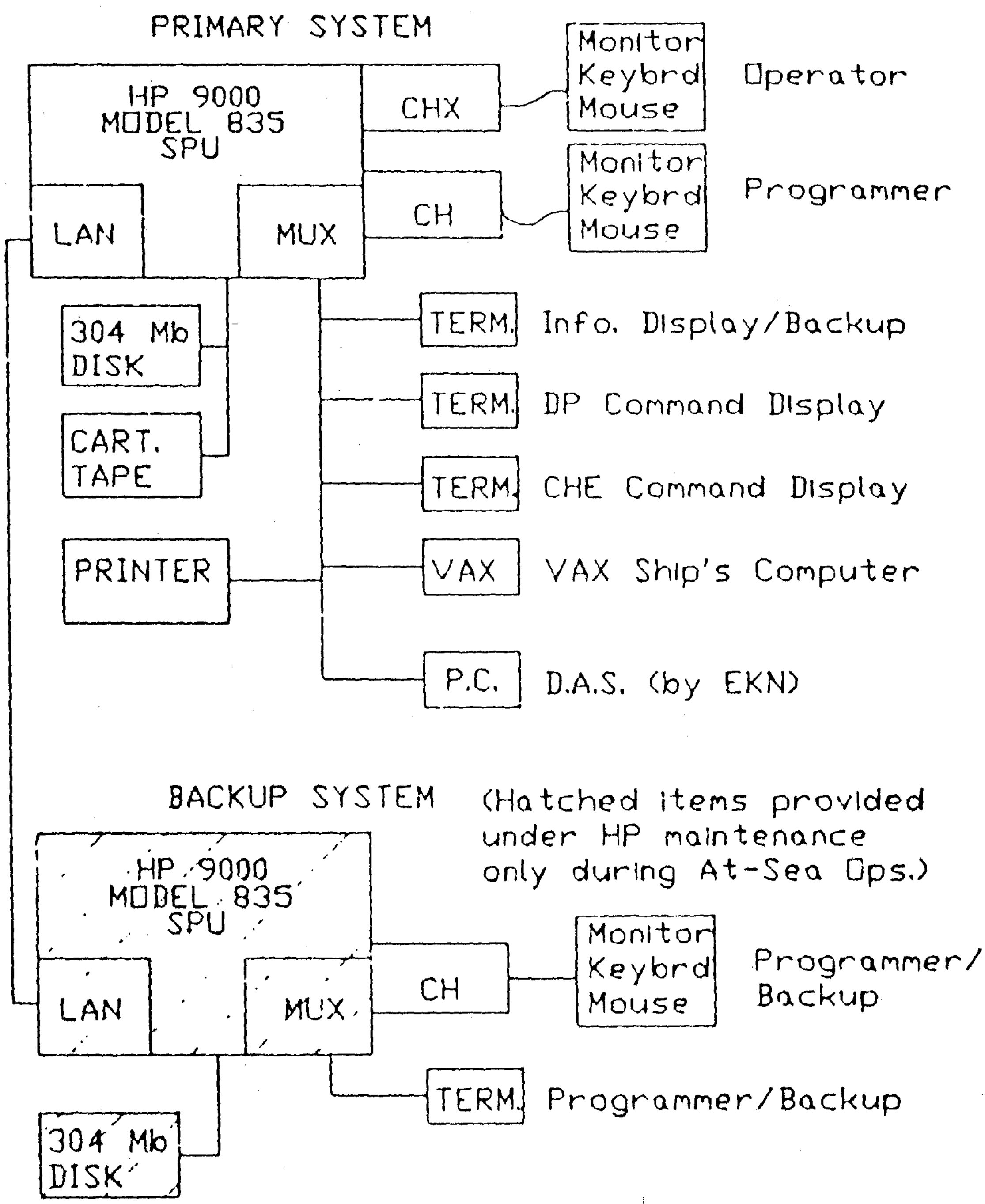


FIGURE 1B.3

a single terminal. This will prevent the confusion of multiple keyboards and the need for multiple monitors.

C. DATA ACQUISITION SYSTEM

The DAS will be installed on the Flexservice 3 and the Kaimalino and be linked via a radio frequency modem. The primary purposes of the Data Acquisition System (DAS) are:

- Acquire data from instrumentation devices and systems and distribute data to the Control System and other subsystems in near real time.

- Record performance of the Control System.

- Record the position, heading and dynamics of the cable ship and of the cable itself, undersea currents, and wave heights. Cable data includes payout parameters at the ship tensioner and position data from acoustic transducers on the cable, near and at the ocean bottom.

- The DAS will be prepared to deliver to the ICS, on demand, a limited history of measured data and cable model parameters to facilitate the rapid restart of the ICS cable model. These data will be supplied by the DAS for a time window specified by the ICS. It is possible to do this because cable model parameters were supplied to the DAS by the ICS in the previous operational interval, for archival recording.

- The DAS also will provide quickly generated reports and charts to support analysis of sensor and subsystem data during the course of the At-Sea Tests. Special reports and tests will be available to assist the operations staff in the calibration and maintenance of the various instrumentation and in troubleshooting the equipment.

The connection of the DAS to other systems is shown in the Figure 1C.1. The DAS obtains data from the ship's computer, the

DAS CONNECTION

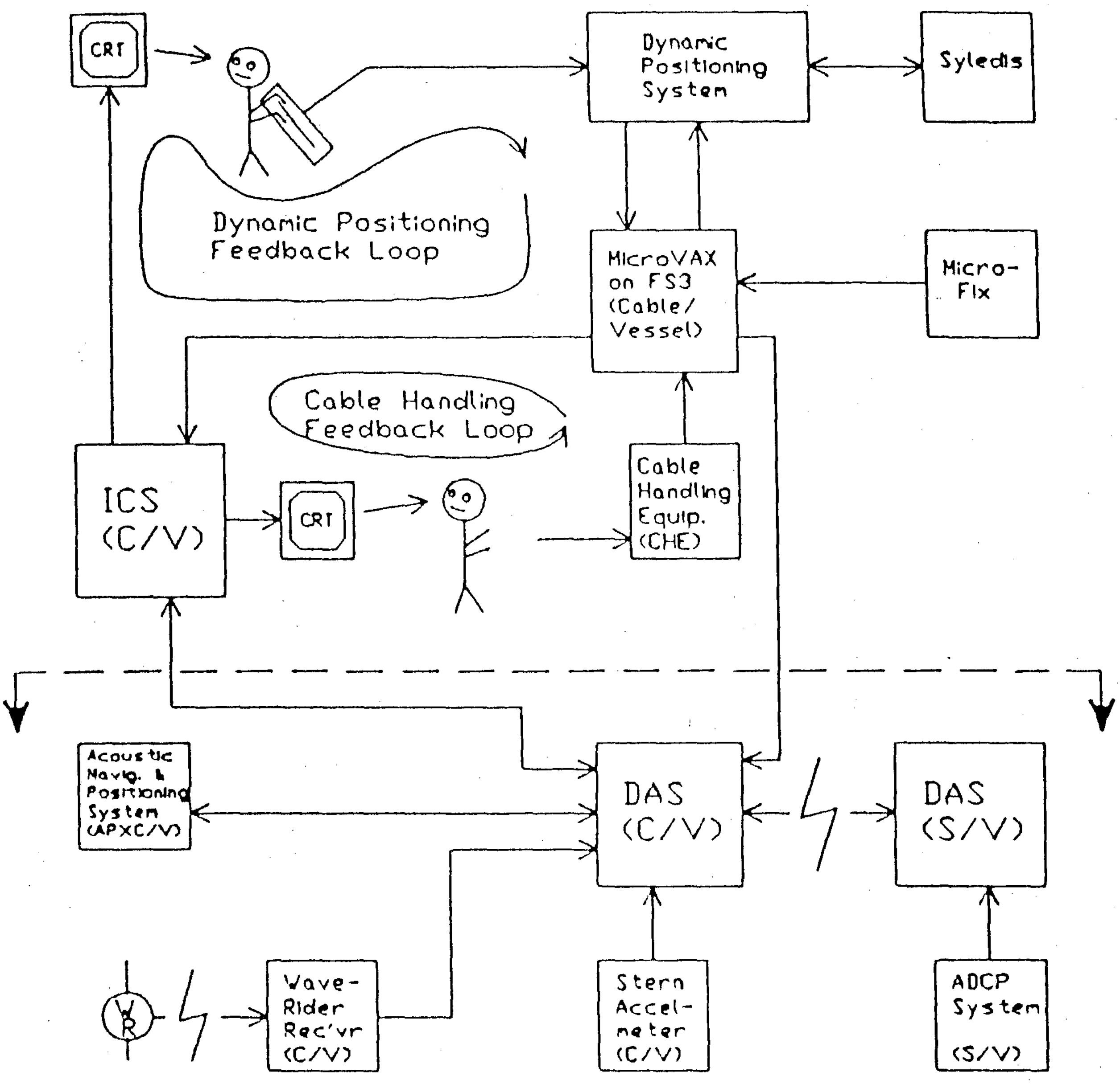


FIGURE 1C.1

ICS and from direct connection to physical sensors mounted on two separate ships, the Cable Vessel (C/V) and the Support Vessel (S/V).

The Geodetic/Surface Navigation System, the Dynamic Positioning (DP) System and the Shipboard Cable Handling Equipment (CHE) are all connected to the ship's computer and channel all of their data through this computer. The DAS does not connect directly to these three systems, but acquires all data regarding their operation through the ship's computer.

The DAS obtains some data directly from sensors in raw, unprocessed form. The DAS will process these data for storage in their more useful normalized forms. The ICS will receive wave height, stern accelerometer (heave, pitch, & roll) and undersea current profile information via the DAS only, obtained by direct connection between the DAS and the measuring devices or their support processors.

The DAS will obtain formatted data from the Acoustic Navigation System computer and the Acoustic Doppler Current Profiler computer and will transmit the data to the Integrated Control System computer. The ANS computer and equipment will be located on the Flexservice and provide position data on the cable mounted transponder and on the underwater manned submersible, Pisces V. The ADCP computer will be located on the Kaimalino and will provide a measure of underwater current velocities in a vertical water column in the vicinity of the cable touchdown point on the ocean floor.

The DAS C/V computer and the principal DAS Operator's position are located in an air conditioned van housed on the cable vessel with the ICS. The principal DAS operator's position is in close proximity to the ICS operator's position so that the two operators are in earshot and immediate view of each other to facilitate communications.

The principal DAS operator is responsible for monitoring and maintaining overall DAS performance, including monitoring the data streams from the sensors and computers to which it is connected on the C/V. A secondary operator's position is located on the support vessel. The main responsibility of this operator is to monitor the operation of the Acoustic Doppler Current Profile (ADCP) system.

DAS CABLE VESSEL EQUIPMENT

A block diagram of the DAS computer, instrumentation and support equipment which are located on the Cable Vessel is shown in Figure 1C.2. Each distinct subsystem or component is identified by a number displayed in a box in the subsystem's symbol on the diagram. These numbers will appear in this section of this report surrounded by square brackets (i.e. [1]).

C/V DAS PROCESSOR : The C/V DAS processor is the primary computer of the DAS system. It is an IBM PC at 100% compatible computer with an 80287 math coprocessor and is located in the same room as the ICS. The principal DAS operator and the ICS operator will be in talking range and in sight of each other during test operations.

DISK STORAGE (C/V): The C/V DAS processor is equipped with one (1) 360 KB 5-1/4 disk drive [1b], one (1) 1.2 MB 5-1/4" disk drive [1a] and one (1) 100 MB hard disk [1c].

ARCHIVAL STORAGE : An Archival Storage Device [1c] is provided as a means of storing historical data when the 100 MB hard disk drive starts to reach the limits of its capacity. The collection of historical data on the archival storage device is called the archival database.

SERIAL DATA CHANNELS : The C/V DAS processor is equipped with four (4) RS-232C serial ports [1i] on one board. Ports #1 & #2 connect the DAS to the Control System computer and to the ship's

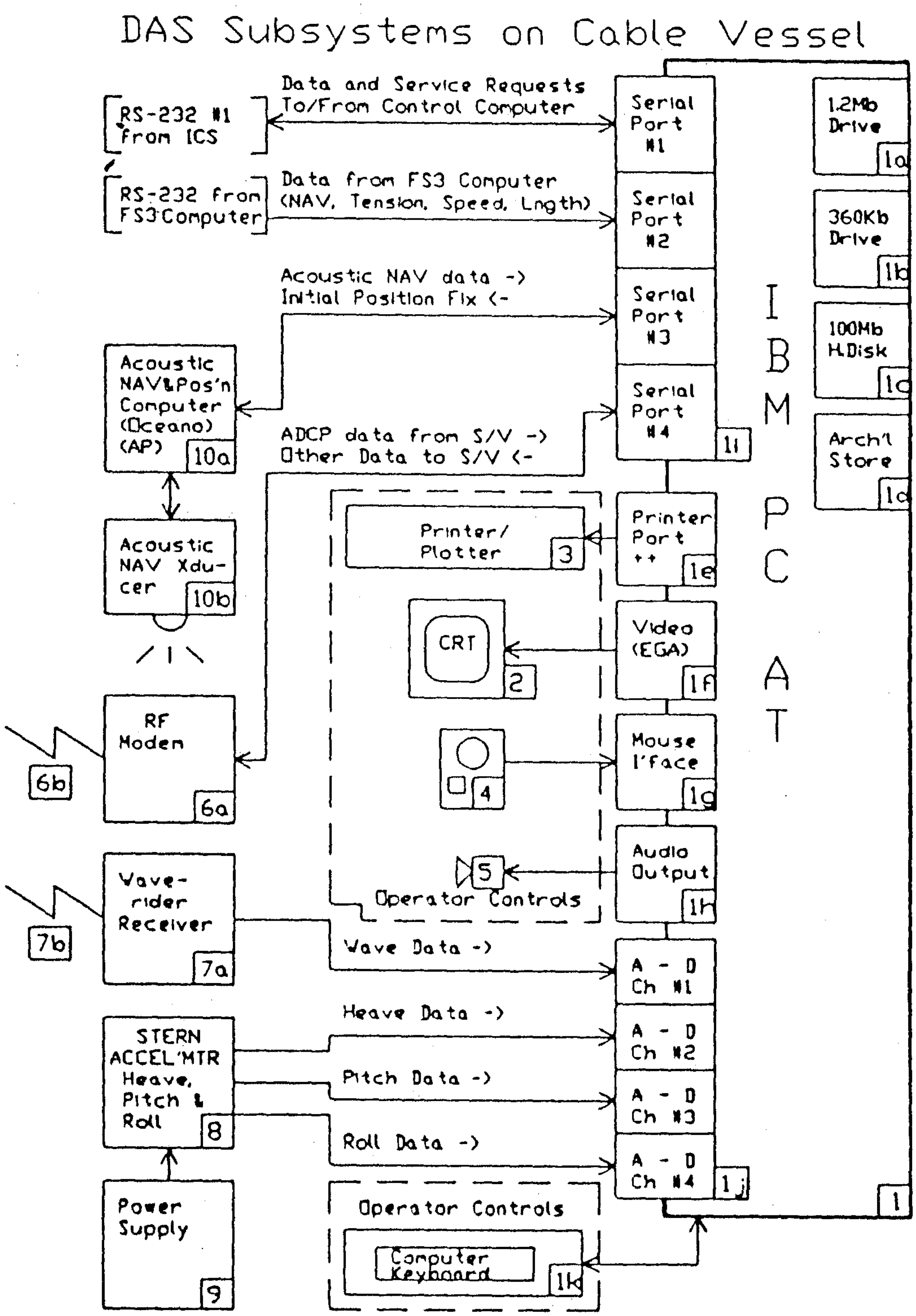

DAS Subsystems on Cable Vessel
Data and Service Requests To/From Control Computer
RS-232 #1 from ICS
Serial Port #1
1.2Mb Drive
1a
Data from FS3 Computer (NAV, Tension, Speed, Lngth)
RS-232 from FS3 Computer
Serial Port #2
360Kb Drive
1b
Acoustic NAV data -> Initial Position Fix <-
Serial Port #3
100Mb H.Disk
1c
Acoustic NAV&Pos'n Computer (Oceano) (AP)
10a
Serial Port #4
1i
ADCP data from S/V -> Other Data to S/V <-
Arch'l Store
1d
I B M P C A T
Printer/ Plotter
3
Printer Port ++
1e
Acoustic NAV Xducer
10b
CRT
2
Video (EGA)
1f
RF Modem
6a
6b
4
Mouse I'face
1g
5
Audio Output
1h
Operator Controls
Wave-rider Receiver
7a
7b
Wave Data ->
A - D Ch #1
Heave Data ->
A - D Ch #2
STERN ACCEL'MTR Heave, Pitch & Roll
8
Pitch Data ->
A - D Ch #3
Roll Data ->
A - D Ch #4
1j
1
Power Supply
9
Operator Controls
Computer Keyboard
1k

FIGURE 1C.2

computer on the Cable Vessel, respectively. Port #3 connects the DAS to the Acoustic Positioning computer which is used to track undersea positional transponders. Port #4 is connected to an RF Modem which establishes a radio data link to the DAS computer on the Service Vessel (S/V).

ANALOG DATA INPUT CHANNELS : The C/V DAS processor also is equipped with a high speed analog-to-digital (A-D) converter [1j] which is used to accept analog inputs (voltage levels) from the Waverider receiver [7] and the stern mounted accelerometer [8]. The A-D converter will support at least four (4) differential input channels. The values are checked for reasonability and are converted into useful form (wave height, heave, pitch and roll) by input compensation and transformation functions tailored to the characteristics (linear or nonlinear) of the respective sensor instrumentation. The normalized values are then stored in the historical database.

OPERATOR'S CONSOLE : The DAS operator's console located on the C/V is the primary operating position for the DAS. It is located in the same air conditioned room on the Cable Vessel (C/V) as the ICS operator, the ICS computer, the DAS computer and the support equipment for both systems.

DAS SUPPORT VESSEL EQUIPMENT: A block diagram of the DAS equipment on the Support Vessel S/V is shown in Figure 1C.3. Each distinct subsystem or component is identified by a number displayed in a box in the subsystem's symbol on the diagram. These numbers will appear in this section of this report surrounded by square brackets (i.e.) [21}.

S/V DAS PROCESSOR : The principal task of the DAS processor on the S/V is to accept Acoustic Doppler Current Profile (ADCP) data from the ADCP processor [27] and to format it for transmission to the DAS processor on the C/V. The S/V DAS processor [21] is an IBM PC AT or 100% compatible computer.

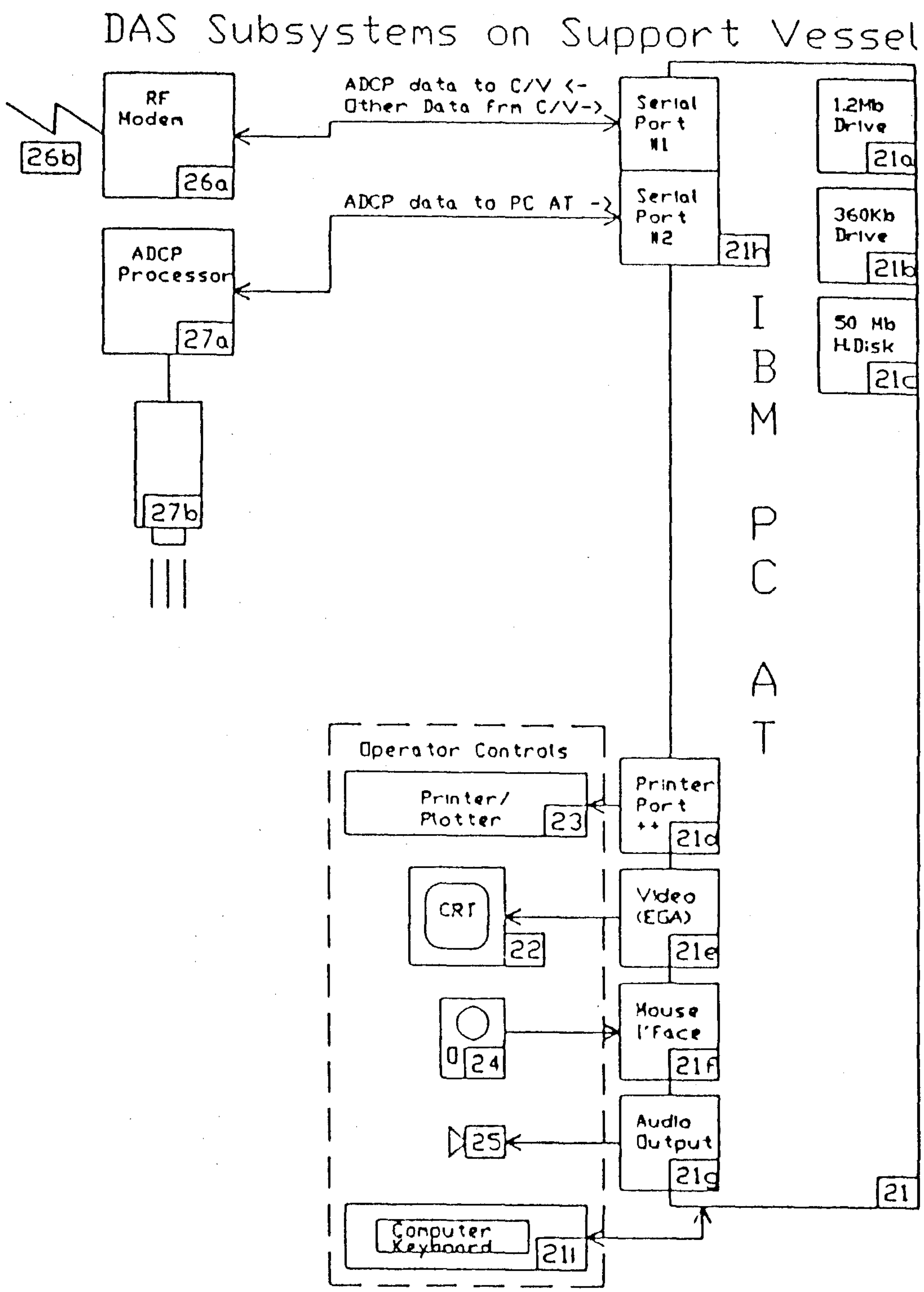

DAS Subsystems on Support Vessel
RF Modem
26a
26b
ADCP data to C/V <-
Other Data frm C/V->
ADCP data to PC AT ->
Serial Port #1
Serial Port #2
21h
1.2Mb Drive
21a
360Kb Drive
21b
50 Mb H.Disk
21c
ADCP Processor
27a
27b
IBM PC AT
Operator Controls
Printer/ Plotter
23
Printer Port ++
21d
CRT
22
Video (EGA)
21e
24
Mouse I'face
21f
25
Audio Output
21g
21
Computer Keyboard
21i

FIGURE 1C.3

DISK STORAGE (S/V): The S/V DAS processor is equipped with one (1) 360 KB 5-1/4" disk drive [21b], one (1) 1.2 MB 5-1/4" disk drive [21a] and one (1) 50 MB hard disk [21c].

SERIAL DATA CHANNELS : The S/V DAS processor is equipped with four (4) RS-232C serial ports [21h] on one board. Port #a is connected to an RF Modem which provides bi-directional digital communication with connected to the Acoustic Doppler Current Profile processor. Ports #3 & #4 are not used.

OPERATOR'S CONSOLE: The DAS Operator's console on the Support Vessel is a secondary operating position. The primary operating position for the DAS is on the C/V. The S/V DAS operator's position is located in an air-conditioned room with a chair and sufficient table space to accommodate the S/V DAS computer, accessories, computer operator controls and support equipment for the Acoustic Doppler Current Profile (ADCP) System and the RF Modem transmitter/receiver.

D. SSP KAIMALINO

The SSP Kaimalino is a Small Water Plane Area Twin Hull (SWATH) vessel operated by the Naval Oceans Systems Center (NOSC) and homeported at the Kaneohe Marine Corps Air Station in Hawaii. Due to the small water plane area design, (Figure 1D.1), heave and pitch motion onboard the ship is minimized. This results in a very stable platform, ideal for scientific use.

The Kaimalino will serve two purposes during the At-Sea Test. Primarily the ship will be a platform for operating the ADCP equipment. The vessel will also be used to deploy retrievable seabed transponders if the installed transponders fail or the bottom array needs to be supplemented with additional transponders. The Kaimalino was used extensively during the Shakedown and Proof of Concept cruises and has been proven capable of performing these tasks.

VESSEL DESCRIPTION

The Kaimalino measures 88 feet long with a 46 foot beam. The working deck space is 45 feet by 50 feet with a 23 by 12.5 foot center well used for deploying underwater equipment. The ship displaces 228 tons of water and has gross payload of 34.9 tons including fuel and ballast.

The twin propeller ship has excellent maneuvering abilities at slow speeds using it's hydraulic motors for propulsion. The hydraulic system is powered by the ship's two 250 KW generators. The ship can steam at 8 knots using a single 2200 horsepower gas turbine.

VESSEL OUTFITTING

The Kaimalino will arrive at Snug harbor for mobilization with a bare deck except for the two hook 3 ton hydraulic deck crane and

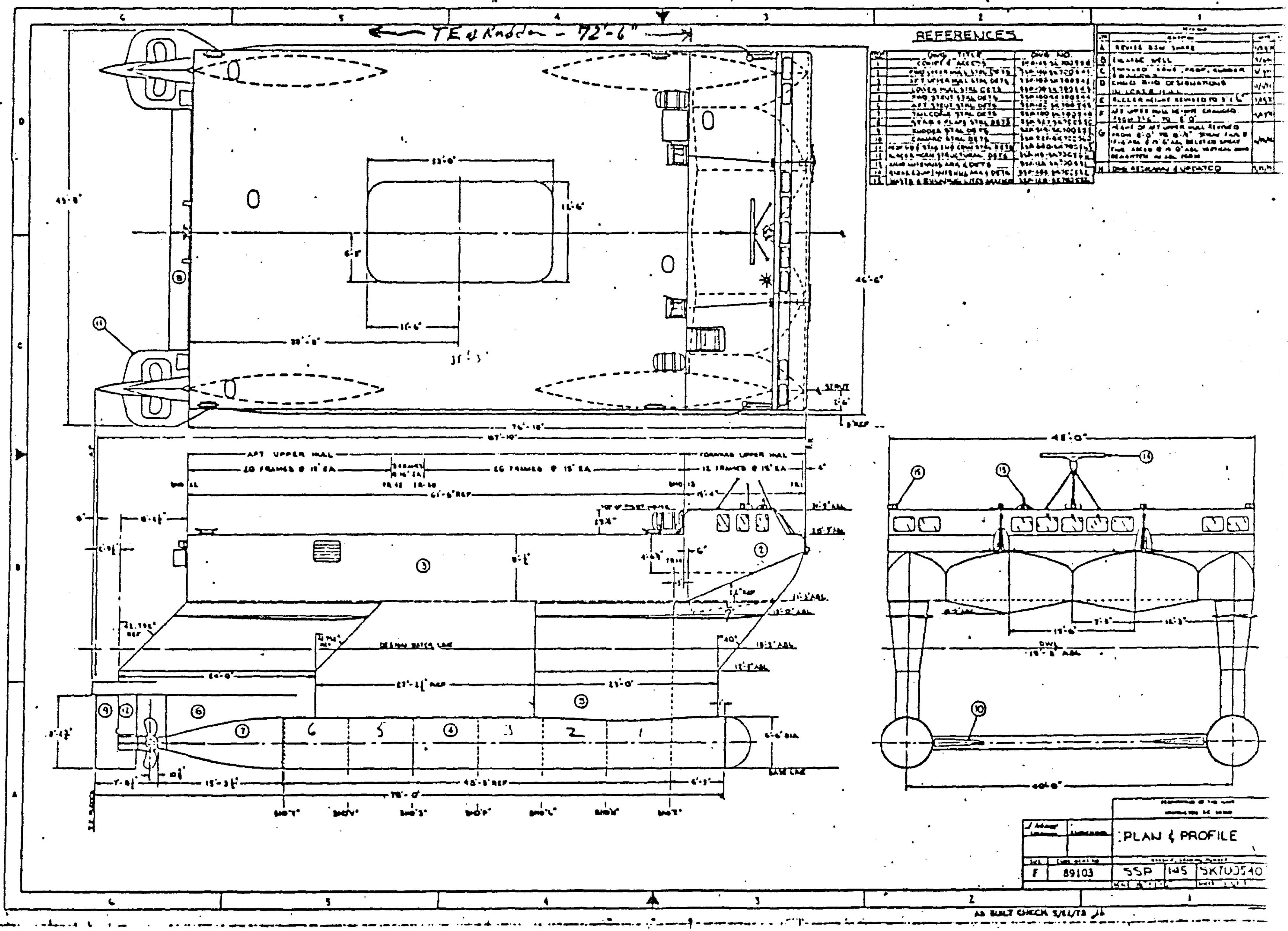


FIGURE 1D.1

the center well A-frame. The following equipment and items will be loaded on SSP Kaimalino:

- The Markey winch and power pack spooled with 6,000 ft of 15/32" OD, 7 conductor EM cable.

- A 150 kHz ADCP, 20 deg. beam angle transducer, two 75 kHz ADCPs, (one with a 30 deg. beam angle transducer and a new unit with a 20 deg. beam angle transducer), and associated computer equipment.

- Racal Micro Fix range navigation system.

- Two 75 Khz ADCP Tow frames (complete with slings and 3,500 lbs of lead weights) and the 150 Khz ADCP hull mounted deployment pipe and stays.

- The support vessel Data Acquisition System (DAS) including the RF modem.

- Navigation Computer System (NCS).

- A 20 foot office trailer securely fastened to the deck. The trailer will house computer equipment and operators.

- Spare seabed transponder assemblies including the anchor, tether, fairing, bridles and floats.

- Radio communication base stations, hand units, and battery recharging stands.

- The A-Frame sheave block and pad eyes.

Appendix 2

EQUIPMENT AND ARRANGEMENTS

A. SURFACE NAVIGATION SYSTEM

Surface navigation will be provided by primary and redundant (backup) radiolocation systems. The following table identifies the systems, their role, and vessel location:

VESSEL	PRIMARY SYSTEM	BACKUP SYSTEM
Flexservice 3	Racal Microfix Coflexip	Sercel Syledis Coflexip
SSP *Kaimalino*	Racal Microfix Rented	Racal Microfix Rented
R/V *Kila*	Mini-Ranger Falcon HURL	Mini-Ranger III EKNA

The support vessel Microfix systems will use the shore transponders set up by Coflexip for the *FS3*, consisting of three stations plus spare transponder(s). Thus, for the S/V only the Control Measurement Unit (CMU), omni-directional R/T antenna and cable need to be provided with 100% backup.

The Microfix can easily provide multi-user capability and in fact has the capability of allowing a maximum of 16 Master (mobile) stations with each system. Multi-user functions would need to be setup, but this is a built-in software capability of the Microfix.

The Surface Navigation Data will be provided to the ICS and DAS and will be integrated via the Navigation Computer System developed by E.K. Noda for presentation in a situation display. A typical display screen is shown in Figure 2A.1.

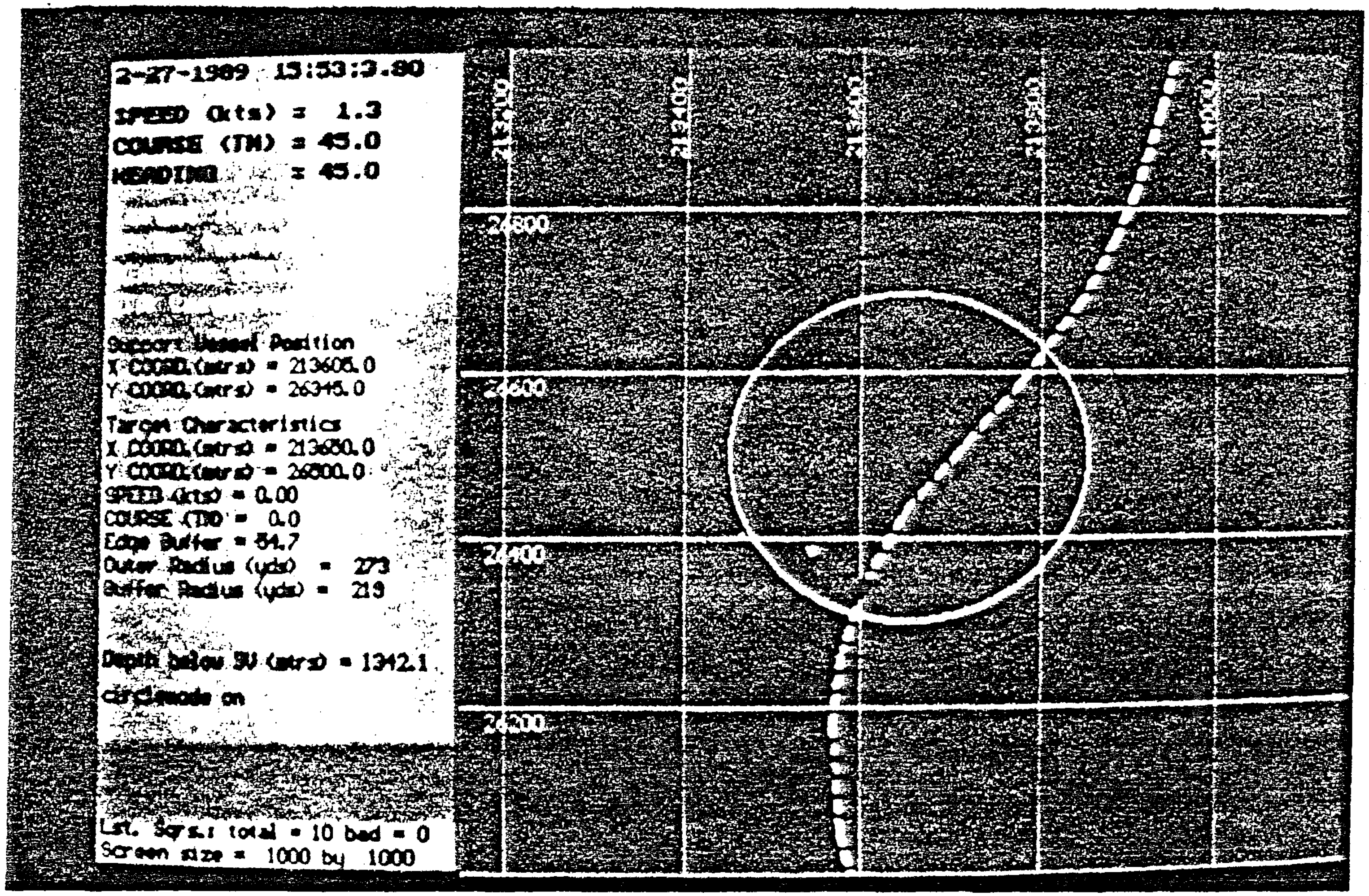

2-27-1989 15:53:3.80
SPEED (kts) = 1.3
COURSE (TM) = 45.0
HEADING = 45.0
Support Vessel Position
X COORD.(mtrs) = 213605.0
Y COORD.(mtrs) = 26345.0
Target Characteristics
X COORD.(mtrs) = 213680.0
Y COORD.(mtrs) = 26500.0
SPEED (kts) = 0.00
COURSE (TM) = 0.0
Edge Buffer = 54.7
Outer Radius (yds) = 273
Buffer Radius (yds) = 219
Depth below SV (mtrs) = 1342.1
circlemode on
Lst. Sqrs.: total = 10 bad = 0
Screen size = 1000 by 1000
26800
26600
26400
26200

FIGURE 2A.1

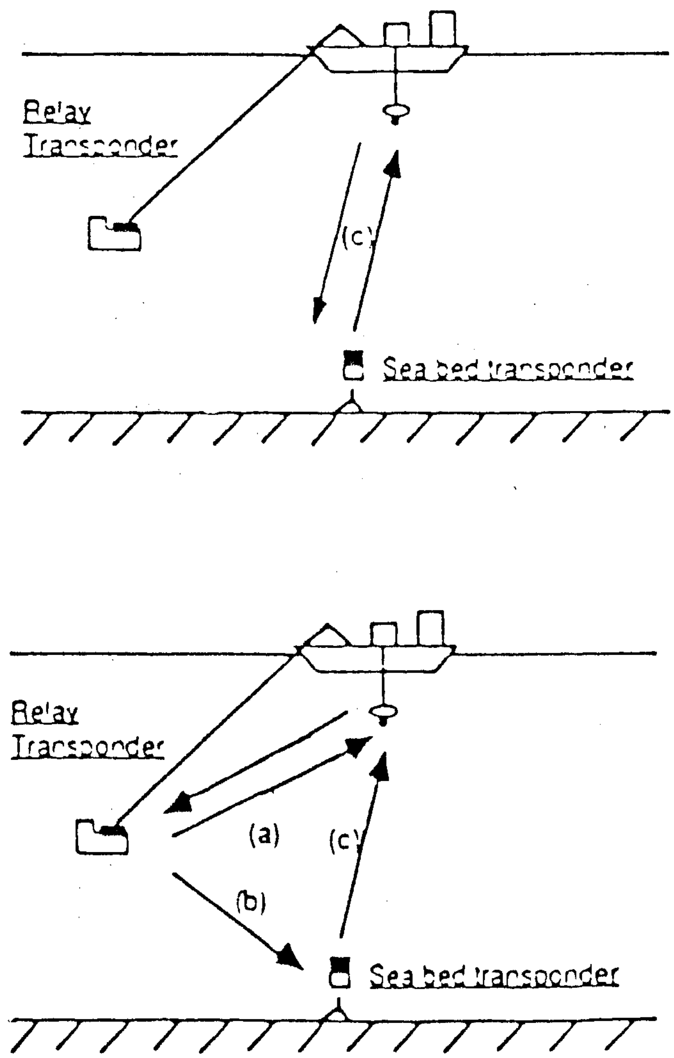
B. ACOUSTIC NAVIGATION SYSTEM

An acoustic navigation system (ANS) will be used to monitor the positions of the cable as it is laid, the submarine Pisces as it dives on the cable, and the ADCP as it records the current profile. The ANS equipment will be provided and operated by Oceano Instruments, USA.

The ANS is a long baseline (LBL) acoustic system specially modified for the HDWCP application. The system operates using two arrays of bottom transponders (one per test lay site) which are calibrated to the USCGS Hawaii Coordinate System, Zone 2. The positions of mobile transponders on the cable, the ADCP tow frame, and Pisces are determined relative to the moored bottom transponders.

LONG BASELINE POSITIONING EQUIPMENT

The LBL positioning principle involves a two sequence operation of the acoustic equipment which is illustrated on Figure 2B.1. First, an acoustic module suspended from the ship commands the bottom (seabed) transponders to reply and measures the travel time for each of the transponders' signals (c). Next, the acoustic module commands the mobile (relay) transponder to reply. The mobile replies and in turn commands the bottom transponders to reply. The module measures the travel time of the mobile reply (a) and the bottom reply (a+b+c). The shipboard ANS computer, called a rangemeter, computes the difference in the signals to obtain the distance between the mobile transponders and the various bottom transponders (b). Triangulation of the distances between the mobile and the bottom transponders results in the position of the mobile. This process is repeated for each mobile transponder. A complete listing of the equipment used to perform this operation is included on Table 2B.1.



Note : Only one seabed transponder is
shown for convenience

FIGURE 2B.1

IV. EQUIPMENT AND ARRANGEMENTS

J. OCEANO EQUIPMENT

1. LEASED EQUIPMENT

ITEM	MODEL #	QUANTITY S/D	AST
RANGEMETER	RM201	2	2
ACOUSTIC MODULE (19 PIN)	AM121	2	2
RT ANGLE MOUNT ASS'Y	-----	1	1
ENDECO V-FIN	703A	1	1
TOW CABLE, 10 CORE, 150 m	----	1	1
SHEAVE BLOCK, 14" DIA.	----	1	1
I/O CABLE, 19 CORE, 100 m	----	2	2
I/O CABLE, 7 CORE, 50 m	----	0	2
TELECOMMAND UNIT	TT301	1	1
INT MOD SVP LNCHR	IM100	1	1
SPARES KIT FOR ABOVE	IM100	1	1
COMPUTER & PERIPHERALS	HP200	2	2
SOFTWARE PROGRAM	LBL6M	1	1
POWER SUPPLY, 28 VDC,10 A	PS100	1	1
AC LINE FORMER	ISOREG	1	1
RECOVERABLE TRANSPONDERS	RT121BS	5	4
FLOAT ASSEMBLIES FOR ABOVE	----	0	4
MOBILE TRANSPONDERS (ADCP & PISCES)	RT121S	2	4
MISC SPARE PARTS KIT		1	1

2. PURCHASED EQUIPMENT

ITEM	MODEL#	QUANTITY S/D	AST
ARRAY TRANSPONDERS	ET261G	16	0
CABLE TRANSPONDERS	ET261G	12	16
SPARE BATTERY KITS	-----	0	1
COMPUTER SUPPLY KITS	-----	2	3
EXPENDABLE SVP PROBES	XSV-2	4	8
MISC.SUPPLY/REPAIR KITS	______	1	2

TABLE 2B.1

3. LOCALLY PURCHASED EQUIPMENT

ITEM	QUANTITY AST
ET ARRAY ANCHOR (SCRAP IRON)	0
RT ARRAY ANCHOR (SCRAP IRON)	4
ET CABLE CLAMP	92
ET CARABINER (2X2 PER TRANSPONDER)	84
ET PENDANT	292
ET WEBBING LOOP	300
AM221 BAFFLE ASSEMBLY	2
EM BAFFLE CABLE, 7 CORE, 350 m	2
ADCP CLAMP ASSEM.	0
PISCES CLAMP ASSEM	1

BOTTOM TRANSPONDERS AND THE SEABED ARRAY

Two arrays, each containing eight bottom transponders, were established during the Shakedown cruise. The positions of these transponders were determined by Oceano. Figures 2B.2 and 2B.3 show the locations along the cable lay paths at each test lay site.

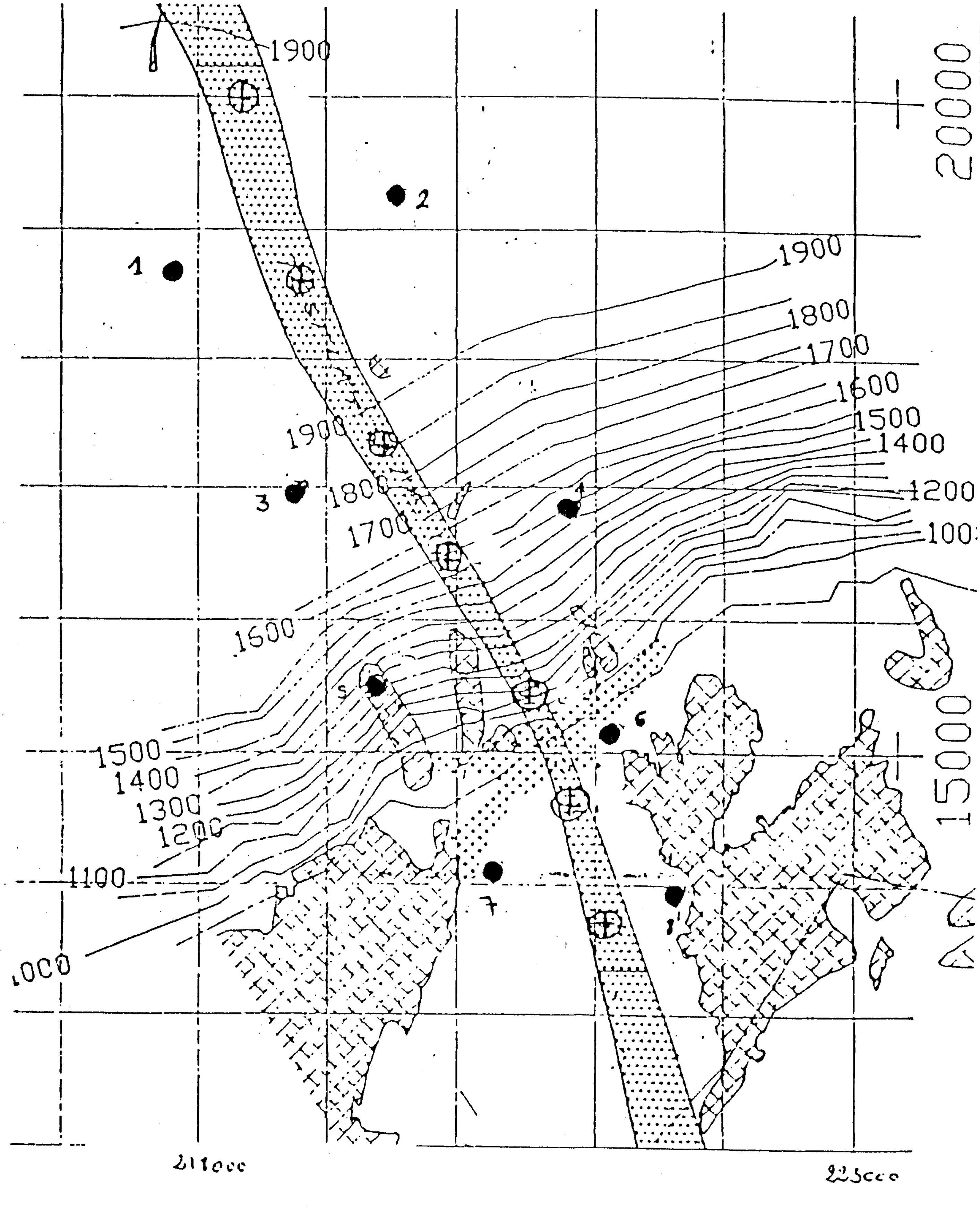
The bottom transponders are encapsulated in a streamlined fiberglass body filled with syntactic foam to provide floatation and minimize orbital excursion of the transponder around its anchor. The transponder is attached to an anchor by 100 feet of faired rope and "floats" above the anchor. The elevation of the transponders off the sea bottom was required due to the uneven contours of the seabed and the importance of having unobstructed paths between the transponders and the bottom of the cable path.

THE ACOUSTIC BAFFLE

An acoustic noise study conducted onboard the Flexservice 3 created concern that excessive noise emitting from the ship would limit the range of the ANS. To ensure that the Pisces would be able to operate a safe distance behind the FS3, Oceano was directed to design an acoustic baffle which would allow the system to track the Pisces at a range of 5 kilometers.

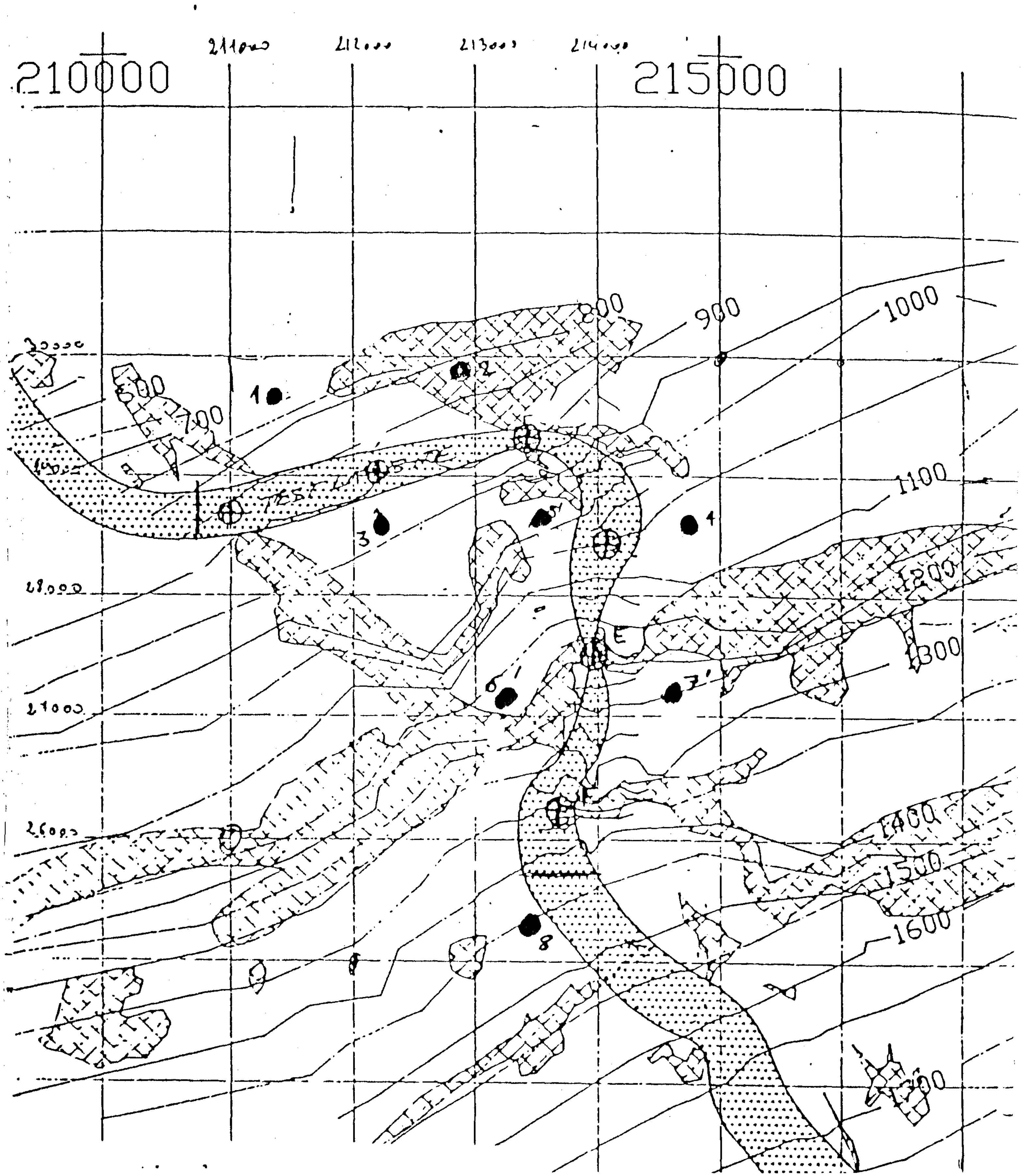
Based upon Oceano's design, a hexagonal shaped steel baffle 5 inches thick by 40 inches wide was constructed to shield Oceano's acoustic module. The baffle is covered on the top with an acoustic isolator material, Isoper, to reflect noise from the ship. Saper-D acoustic covering is applied on the bottom of the baffle to absorb noise. Both these materials are manufactured by B.F. Goodrich.

The baffle will be suspended from the Flexservice by a seven conductor electro-mechanical cable at a depth between 200 and 400 meters. The exact depth will be determined when the performance



● BOTTOM TRANSPONDERS - HAWAII SLOPE

FIGURE 2B.2



BOTTOM TRANSPONDERS - MAUI SLOPE

FIGURE 2B.3

of Isoper and Saper-D under high pressure is observed at sea. The cable will have fairing installed to reduce excursion and vibration.

MOBILE CABLE TRANSPONDERS

The Acoustic Navigation System includes 28 transponders for attachment to the cable as it is laid. Because only 16 independent frequencies are available, only 5 mobile transponders attached to the cable (plus one on Pisces and one on the ADCP tow frame) can be tracked at any one time. As a cable attached transponder reaches the bottom, it will be disabled acoustically, and a new transponder which had been previously attached will be enabled, thus maintaining the number at 5 active transponders on the suspended cable.

Factory-sealed, vacuum sealed transponders will be used, and will not be opened during the AST.

Once a transponder has been retrieved, the only functions that can be checked are the enable and disable functions and response to acoustic command. These can be performed by personnel after a short technical training program. The deck check-out of a transponder can be performed by deck personnel under supervision of Oceano.

In coordination with Makai, Oceano will prepare an acoustic transponder attachment schedule prior to each test lay. The preparation of the attachment schedule will be based on the on-deck evaluation of each transponder after it is retrieved and the frequency characteristics of the individual transponders.

The frequencies are factory set. Each transponder has two frequencies, and should a transponder fail, it must be replaced with a unit with the same frequencies or the entire schedule must be changed such that there is no frequency duplicated in a continuous string of say 5 or 6 transponders.

The Coflexip Offshore Manager on the _FS3_ is responsible for attaching the selected transponder to the cable at the specified location.

Careful coordination and documentation will be necessary between the Oceano ANS operators, the Makai ICS Supervisor, and the Coflexip Offshore Manager on the _FS3_. While the management of the transponders on the _FS3_ is not a continuous task requiring constant supervision, it can be considered full time work in the sense that the operation extends around the clock.

C. FLEET MANAGEMENT COMPUTER SYSTEM (FMCS)

The following provides a description and specifications for the FMCS Display for the Fleet Management Office on the FS3 during the AST.

1. The FMCS display will be a plan view in at least two different screen scales. The primary scale will have a full screen width/length of about 600-700 meters, while a secondary display will have a full screen width/length of about 7000 meters. The change in scale will be easy to implement, such as a keystroke control. The primary scale is to provide a better resolution of the FS3, the SSP Kaimalino, and the mobile transponder locations, while the secondary screen is to provide a overall view of all the vessels including the Pisces V and the R/V Kila.

2. For the primary screen, because the interest is the real time view of the operations, the screen will be centered on the stern reference point of the FS3. Thus, the coordinate system will move instead of the FS3.

3. The secondary screen will not be set at a particular scale but instead the computer will select the scale. The display will again be centered on the FS3 and the scale adjusted to include both the Pisces V and the R/V Kila which will be near the edge of the display. There is no automatic update for the R/V Kila, and consequently this must be input manually. Second, the update rate for the Pisces V will be at best once every 140 seconds, and quite possibly worse due to the inability of the ANS to interrogate the Pisces V transponder. Thus, the FMCS should create a file of Pisces V and R/V Kila positions, including the time. When the secondary display is required, use the last positions of these vessels and display the time of this last position on the screen.

4. The list of items that will be displayed on both the primary screen and secondary screens is as follows:

GRAPHICS

a. FS3 with its proper size and heading

b. HPR transponder location

c. Locations of the bottom-mounted acoustic navigation transponders. These will be provided by Oceano at the beginning of the AST and manually entered into the program file.

d. Real-time plan view positions of the mobile acoustic transponders which would include the 5 mobile units attached to the surrogate cable, the unit attached to the ADCP, the units on the Pisces V and the location of the HPR attached to the AM-Baffle. Note that the FMCS will only receive an update of one mobile transponder every 20 seconds. Thus, a file of mobile transponders will be created, and whenever a display is desired, the latest mobile transponder positions will be used. A series of dotted straight lines connect between the mobile transponders on the cable. The display will place the number code of each mobile transponder on the display, adjacent to the transponder.

e. The position, heading and proper size representation of the SSP Kaimalino.

f. The location of the planned cable lay path. This data will be provided by MOE prior to the cruise and will not change during the cruise.

g. Coordinate grid.

Note that the above display items do not change as a function of the screen display scale (primary or secondary). If the object is not within the view of the screen, it is not plotted.

In addition to the above display items which are either known before the cruise or which are obtained by the DAS, the following additional graphical information is provided:

a. The position of the R/V Kila will be shown in the secondary screen display. Whenever the FMCS operator desires to update the R/V Kila position, the operator will call the FS3 bridge and obtain the radar range (nautical miles) and bearing to the R/V Kila and FS3 gyro heading. The operator will then terminate graphics, and punch in the above 3 variables plus time of recording, which will be stored in the R/V Kila position file as the latest update. The FMCS will then calculate the absolute position of the R/V Kila and store this position in the file in place of the above variables or in a separate file. Then the R/V Kila's updated position will be displayed on the CRT.

b. At the beginning of each the Pisces V dive, the Pisces V will be directed by the Test Director to a specific location on the bottom to begin the reconnaissance. This x,y bottom target location will be punched into the FMCS and displayed when required. The ADCP QA computer system will also calculate the surface launch position in order to hit the bottom target location based on the most relevant ADCP current profile data. This surface launch location will be verbally provided to the FMCS via radio from the SSP Kaimalino, and this position will also be punched into the FMCS and displayed as required.

TABULAR DATA

In addition to the above graphical display data, some information is required in a tabular format. This will be the following:

a. Date and Time
b. FS3 x,y coordinates in real time.
c. Kaimalino x,y coordinates in real time.
d. Pisces x,y coordinates and time of last update.
e. Kila x,y coordinates and time of last update.
f. Distance between FS3 stern and HPR on baffle.
g. Significant wave height H_s and time of last update.
h. Wind and surface current component from ship's computer.

D. CONTROL VAN LAYOUT

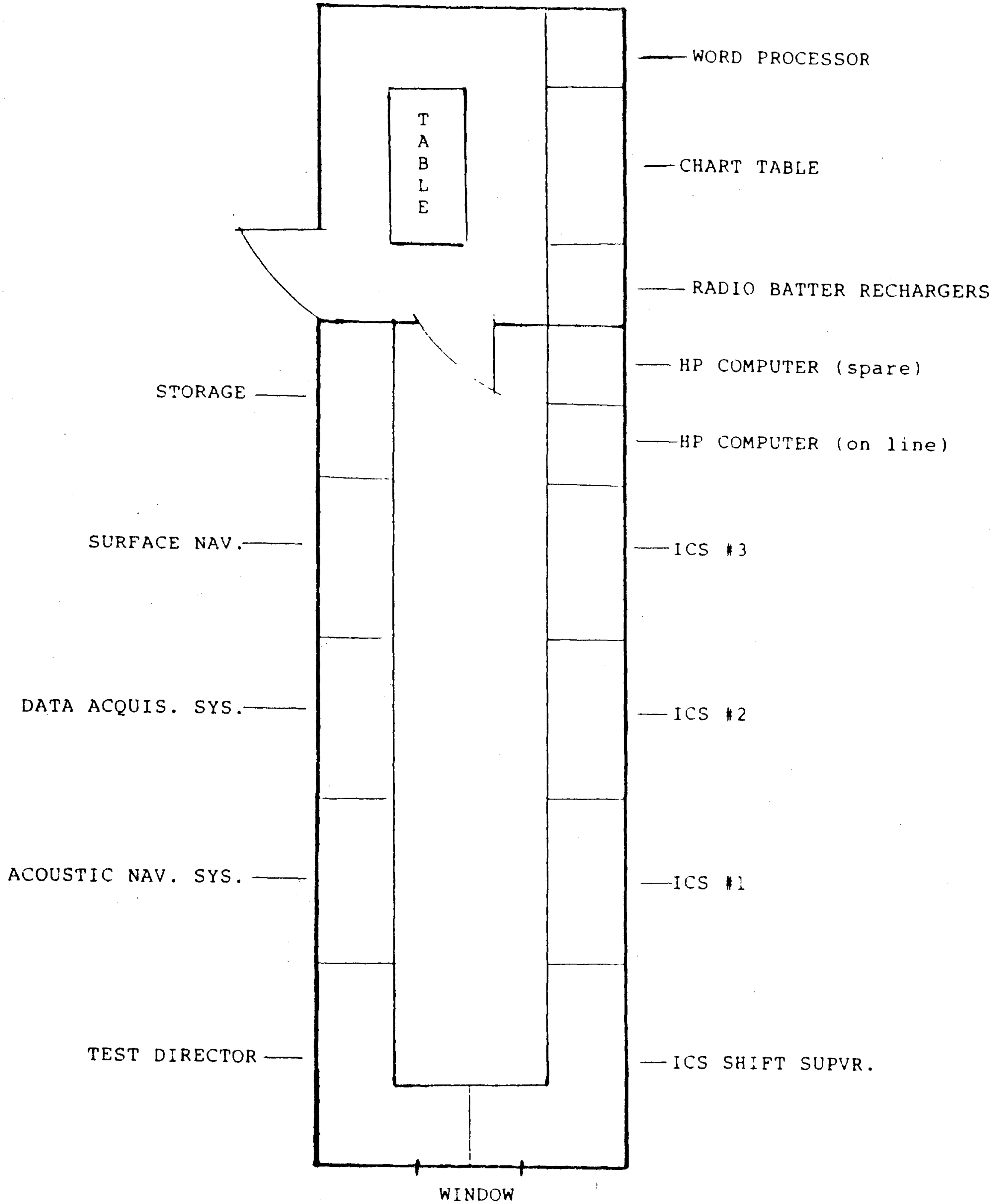
A structurally reinforced field office trailer approximately 12 feet by 44 feet will serve as the At-Sea Test control van onboard FS3. The van will function as command center for the AST operations. The various AST computer systems and operators, the ICS shift supervisor, and the Test Director's work station will be located there. A small conference room will also be available in the van.

The trailer will be outfitted with air conditioning, lighting, electrical outlets, shelves, and counters as required to support the equipment and operators of the following systems:

- Integrated Control System
- Data Acquisition System
- Acoustic Navigation System
- Surface Navigation Computer System
- Fleet Management Computer System

A partition shall separate the conference room from the system operators as shown on Figure 2D.1. The requirements for the Test Director's station and the conference room are listed on Table 2D.1.

The van will be mobilized at Snug Harbor prior to the arrival of the Flexservice 3. The majority of equipment will be installed and tested on the dock in order to reduce the number of required FS3 mobilization days. The van will be loaded onto the FS3 intact, and secured upon the raised platform above the cable tensioners. The FS3 crew will be responsible for lashing-down the van and providing electrical power.



CONTROL VAN LAYOUT

FIGURE 2D.1

Table 2D.1

TEST DIRECTOR'S WORK STATION

1. COMPUTER TERMINAL NAV SITUATION DISPLAY (DAS)

Coordinate Grid (500 m Screen and 10,000 m Screen)
Desired Cable Track
Vessel Position: FS3, Kaimalino
Kila Position (input) (From Bridge Radar Range & Bearing)
Cable Position (Plan View) with Active XPDRS
XPDR Locations in Area
Distance: HPR on Acoustic Module/Baffle vs. Cable
Pisces Dive Start X,Y (input)
Pisces X,Y during Dive (ANS output)
Pisces Bottom Target X,Y (input)

2. COMPUTER DISPLAY - AMBER - ICS CABLE LAY REPEATER

Date & Time (2400 clock)
FS3 Speed, Course, Heading
Cable Length Out
Distance to Next XPDR Attachment Point
Elapsed Time Since Start Lay
Cable Tension - Surface
Cable Distance Error vs. Desired Touchdown
Cable Tension (Calc and Desired) at Bottom
Bottom Current
Waverider: Significant Wave Height

3. HARD WHITEBOARD WITH GRID AND SITE LAYOUT

Rough Positions of Vessels including Pisces
Notes/Status & Plans of Pisces

4. RADIO/COMMUNICATION REQUIREMENTS

Marine Band Scanner Base Station
HDWCP Radio Base Station
Log Book

5. CONFERENCE ROOM REQUIREMENTS

Conference Table, Chairs
Recharging Rack for Radio Batteries
VHS Video Camera
Hard Whiteboard Bulletin Board
(Time & Note of Planned Events)
(Weather Forecasts)

E. TENSIONER OPERATOR'S DISPLAY

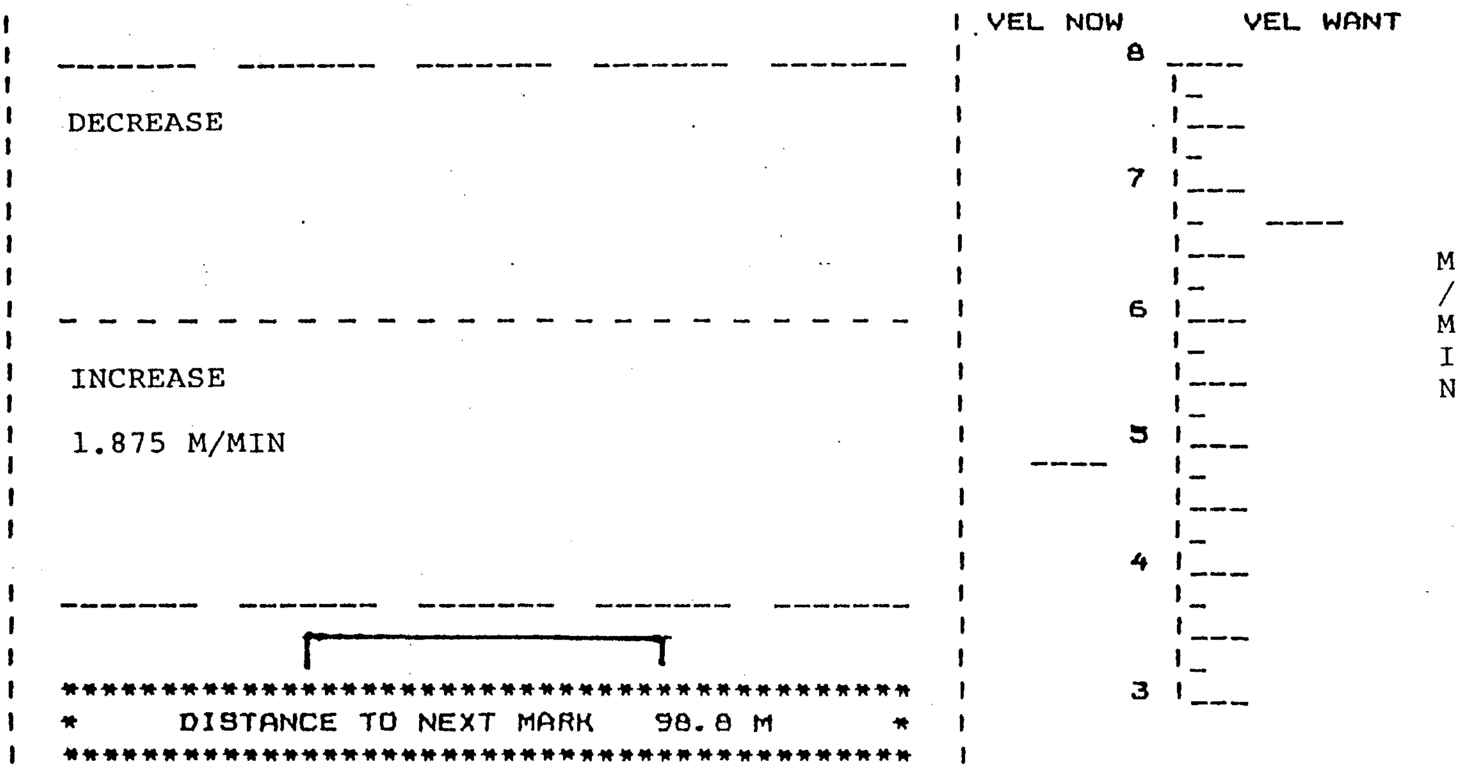
The ICS will send commands to the Coflexip operator at the cable tensioner, which will be displayed on a remote computer monitor installed in the tensioner control van.

Voice warnings will be given to the tensioner operator when possible, in advance of important changes such as "Start Payout". However, most commands will be sent only to the computer monitor display, which will be mounted at the operator's station.

The display will flash and change color when a significantly changed instruction is being sent.

A sample graphic display is presented on the next page.

TENSIONER OPERATOR DISPLAY



SITUATION: LAYING CABLE, LARGE SPEED INCREASE REQUIRED

LARGE BAR AND INSTRUCTIONS "INCREASE 1.875 M/MIN"
WILL FLASH AND MONITOR WILL BEEDP TO ALERT OPERATOR.

F. <u>NOT USED</u>

G. ACOUSTIC DOPPLER CURRENT PROFILERS

GENERAL

RD Instruments Acoustic Doppler Current Profilers (ADCP's) employ the acoustic doppler current profiling technique to remotely measure undisturbed flow velocity at multiple locations in the water column. A single instrument produces a profile of currents which for conventional "single point" current meters could only be obtained with a large array of many individual current meters or by mechanically scanning a single current meter. The water velocity measured by the instrument is relative to the instrument and may not represent the true ocean current.

The RD instruments ADCP's operate by transmitting short acoustic pulses into the water along the lines of position defined by one or more highly directional transducers. Typically, four vertically inclined beams are used. Backscattered sound from plankton, small particles, and small scale inhomogeneities in the water is received by the transducer with a Doppler frequency shift proportional to the relative velocity between the scatterers and the transducer. A time series of measurements of the Doppler frequency shift after sound transmission produces a range segmented picture (or profile) of the water flow velocity versus range along the lines of position defined by the four beams. By knowing the precise beam geometry, three orthogonal current velocity components for each "depth cell" or "bin" are computed by combining the measurements from any three of the four beams. Normally only the horizontal current profile is recorded as North & East current components as a function of depth. Each depth resolution cell shown in the plot represents the average current velocity through a horizontal "slice" of the water column in the region bounded by the four beams.

AT-SEA TEST CONFIGURATION

The ADCP will be operated onboard the SSP Kaimalino by engineers supplied by Evans-Hamilton, Inc. The At-Sea Test will be configured with two ADCPs with each unit reporting 15 bin velocity measurements.

A 150 Khz ADCP will be mounted to the hull of the Kaimalino as shown on Figure 2G.1. This unit unit will provide velocity measurements to a depth of 500 meters.

A 75 Khz ADCP will be mounted inside a weighted frame as shown in Figure 2G.2. The unit will then be lowered using the Markey winch. The ADCP will operate approximately 700 meters above the ocean bottom. At this depth, the unit will be able to utilize its bottom tracking ability which provides data on the velocity of the instrument itself.

The ADCP computer system onboard the Kaimalino will use the bottom tracking information to derive the actual current of the water column. The system will also combine the output from both the units and use an interpolation subroutine to estimate currents between the two ADCP's ranges and an extrapolation subroutine to estimate currents near the sea bottom. The computer system will then output continuous water velocity profiles to the DAS in near real time.

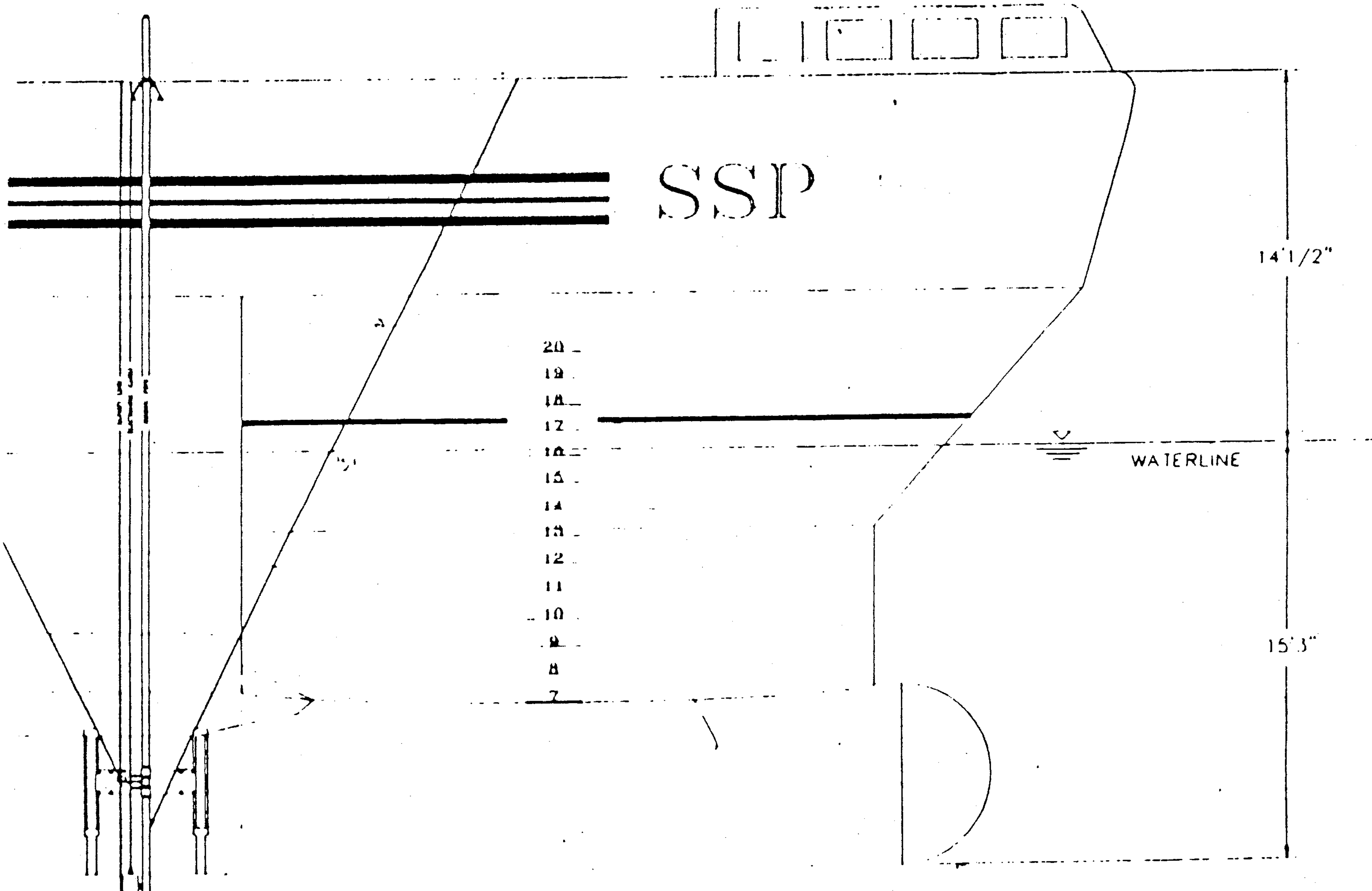


FIGURE 2G.1

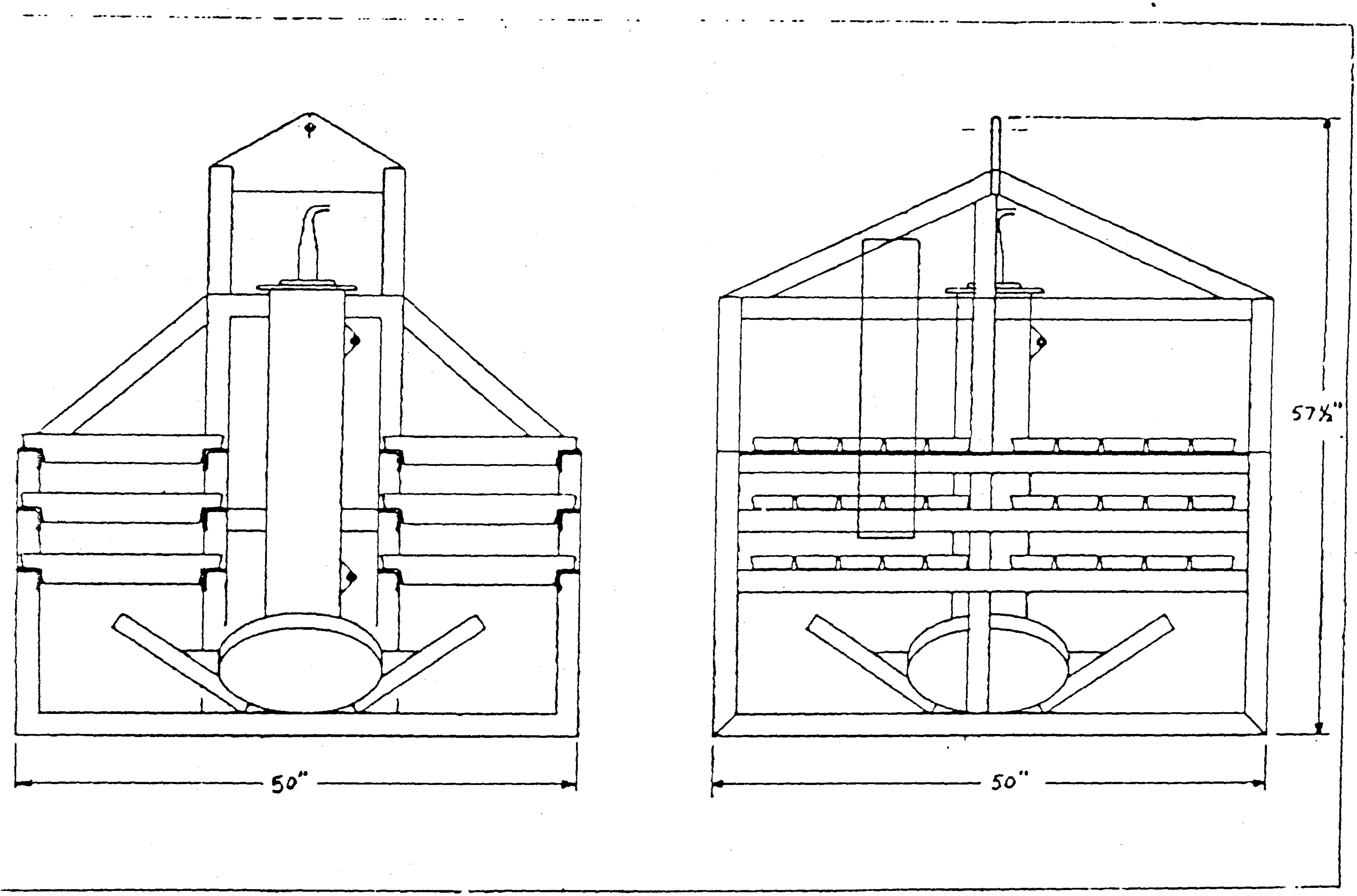


FIGURE 2G.2

H. WAVERIDER BUOY

To minimize operational problems during the AST, the Waverider buoy will be moored at a single location during the entire period. Figure 2H.1 shows the approximate locations of the two Testlay sites. The Waverider will be moored to the existing NOAA buoy mooring as shown in the figure. While NOAA has removed the wave & wind measuring buoy, they have placed another lighted surface buoy in its place. For winds from the northeast (tradewinds) the NOAA buoy mooring location is believed to be representative of both sites. As the post analysis will be a frequency evaluation, it is expected that the spectral content of the waves measured at the proposed site should be an adequate representation for both Testlay sites.

The Waverider will be deployed in the channel in the week prior to arrival of Flexservice 3. Deployment will be carried out by E. K. Noda.

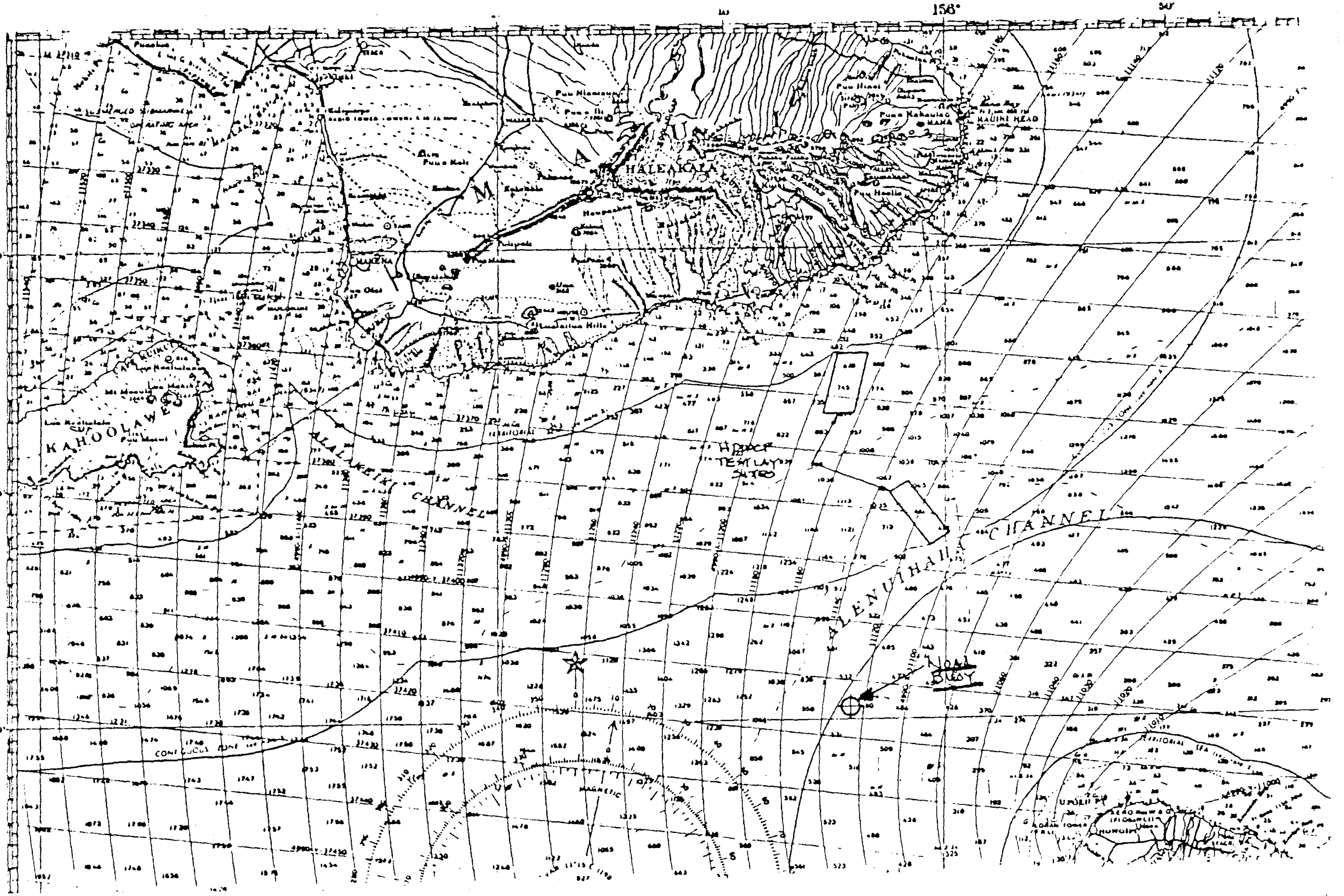

156°
50'
HALEAKALA
MAUI
KAHOOLAWE
ALALAKEIKI CHANNEL
ALENUIHAHA CHANNEL
MAKENA
HANA
HAUINI HEAD
HOAA TEST LAY SITES
NOAA BUOY
MAGNETIC
TERRITORIAL
CONTIGUOUS ZONE
UPOLU PT
KAUPO
KEONEOIO
30'
20°

FIGURE 2H.1

I. RADIO COMMUNICATION EQUIPMENT

The radio requirements for the At-Sea Test are described below and listed on Table 2I.1. Miscellaneous frequency assignments and Communications are included on Table 2I.2.

1. A total of 18 communication radios will be employed during the At-Sea Test. Eight of these will be stationary base units which operate on 110 V A/C power. Ten will be portable hand units.

2. Radios will be issued to subcontractors by HD&C. Company representatives will sign for the radios on the control log shown on Table 2I.3.

3. Spare batteries and rechargers will be provided for hand radios in the conference section of the ICS Control Van. HD&C will recharge and rotate batteries every twelve hours.

4. Spare hand mikes and/or ear phones will be provided for the locations which use the accessories.

5. Each radio will operate on four common frequencies. These are:

CHANNEL	FREQUENCY	CALL SIGN
1	463.8375	KB3061
2	463.8625	KB3061
3	464.5000	WNHF238
4	463.8125	KB3061

6. Channel one will be the main operational channel during the cable laying operations. Channels 2 through 4 will be alternate channels for conducting conversations.

7. All radios will have the ability to penetrate the ship hulls for line of sight operation.

Table 2I.1

RADIO COMMUNICATION UNIT LIST

CABLE LAYING VESSEL - FLEXSERVICE 3	
BRIDGE MONITOR	BASE
BRIDGE SPARE	HAND
ICS/FMCS VAN MONITOR	BASE
HECO REPRESENT - PW	HAND
TEST DIRECTOR - FAM	HAND
ICS DIRECTOR - JVR	HAND
TRANSPONDER ATTACH SAILOR	HAND
WINCH OPERATOR	BASE
DECK LEADER	HAND
TENSION OPERATOR	BASE (W/ EARPHONE)
SPARES	HAND(2)
SUPPORT VESSEL - KAIMALINO	
BRIDGE MONITOR	BASE
DAS VAN MONITOR	BASE
DAS DIRECTOR - EKN	HAND(W/ HAND-MIKE)
AUXILIARY VESSEL - KILA	
BRIDGE MONITOR	BASE
SPARE	HAND
SHORE STATION - KILA	
GRAY RESIDENCE	BASE
MOBILE PORTABLE	HAND

Table 2I.2

COMMUNICATIONS FREQUENCY ASSIGNMENTS

1. SURFACE COMMUNICATIONS NETWORK

A. VHF Marine Band Channel 16 - monitor at all times.

1. All vessels - Bridge, Master

B. VHF Marine Band Channel 10.

1. Dillingham Project Manager office on FS3 other vessels; (used for vessel to vessel coordination in planning and navigation, available for consultation between Dillingham and Subc on other vessels.)

C. VHF Marine Band Channel 26.

1. Maui Marine Operator for Land Telephone Calls

2. UNDERWATER FREQUENCIES IN USE

A.	Oceano NAV Transponders	8-16 kHz
C.	Pisces to Kila comm	27 kHz
D.	ADCP	75 & 150 kHz

3. OTHER FREQUENCIES

A.	Mini-Ranger	5.48 GHz
B.	Microfix	5.48 GHz
C.	Syledis	TBD
D.	DAS - RF Moden DAS - RF Modem	464.55 MHz 469.55 MHz

Hawaiian Dredging & Construction Company

RADIO CONTROL LOG

THE FOLLOWING MOTOROLA RADIUS P200 PORTABLE UHF RADIO AND ACCESSORIES VALUED AT $1000.00 HAS BEEN ISSUED TO THE FOLLOWING AS NOTED BELOW:

NAME	COMPANY	EQUIPMENT	SERIAL NUMBER	DATE ISSUED	INIT.	DATE RETURNED	INIT.

TABLE 21.3

Appendix 3

MISCELLANEOUS INFORMATION

A. <u>LIST OF ABBREVIATION</u>

Accelerometer	Cable vessel stern accelerometer and its power supply
ADCP	Accoustic Doppler Current Profiler
ANS	Seabed Acoustic Navigation Positioning System
CHE	Cable Handling Equipment
CHE CRT	Display located in the Cable Tensioner Control Room
CP	Coflexip and Services, Inc.
C/V	<u>Flexservice 3</u> Cable Vessel
DAS	Data Acquisition System, including the two modems for digital data transmission betweenthe cable vessel and the support vessel
DP CRT	Display, part of the cable vessel dynamic positioning system
EKNA	Edward K. Noda and Associates, Inc.
<u>FS3</u>	<u>Flexservice 3:</u> micro computer linked with dynamic positioning system, Syledis and Miscrofix; CHE aboard
HDC	Hawaiian Dredging and Construction Co.
HP	Hewlett Packard HP 9000 Series 800 Computer
ICS	Integrated Control System
MOE	Makai Ocean Engineering, Inc.
<u>PISCES S/V</u>	<u>Pisces V</u> Support Vessel
S/V	Support Vessel
Waverider	Wave Height Monitoring System, the floating buoy radio linked with its associated receiver

B. TELEPHONE CONTACT LIST

AMERICAN DIVERS	545-5190
Scott Vuillemot	
BAKER NUMBER	
KAIMALINO	2337
FLEXSERVICE 3	4039
JOHN BOWEN	524-4440
FRIS CAMPBELL	984-7640
HARRY CHALMERS (NOSC)	257-5442
OFFICE	257-5442/5443
SECRETARY	257-5293
TELECOPY	257-5231
TELECOPY OPERATOR	257-5248
MIKE YOUNG	257-5196
ROY YUMOC	257-5454
COFLEXIP	713-789-8540
AL COUPER (MAUI) (ALSO ON VHF)	1-248-8395
EVANS-HAMILTON	713-495-6159
EVER READY MACHINE SHOP	841-6422
TOM GARRITY	212-839-1466
HAWAIIAN ELECTRIC	543-7534
HAWAIIAN TUG & BARGE	543-9352
HD&C (Operator)	735-3211
Advanced Projects Office	941-1597
FAX number	949-2454
Cellular Phone	225-0295
Frank McHale	
Dave O'Day	
Darwin Sen	
HILO HARBORMASTER	1-935-7565
HONOLULU HARBORMASTER	548-4134
KAWAIHAE HARBORMASTER	
Henry Pasco	1-882-7565
LOUIS P.LOPEZ	396-6695/921-6903

HURL		
Dr. Alex Malahoff		948-6802/948-6335
Terry Kerby		259-9991/FAX 948-9646
MAKAI OCEAN ENGINEERING		259-8871
Joe Van Ryzin		
Andrew Resnick		
MATSUMOTO, HARU		
	(office)	948-8790
MAUI HELICOPTER		879-2622
24 hr pager		877-8397
Mike Williams		
Eric Lincoln		
MAUI MEMORIAL HOSPITAL		1-244-9056
NELH KONA		
Tom Daniels		
Jan War		
Kent Merrill		
Guard		1-329-4114
EDWARD K. NODA & ASSOCIATES		533-0553
PARSONS HAWAII		523-5464
JIM PRENTICE		
SEA ENGINEERING		259-8582
SEACO (DAVID LIPP)		261-7955
SNUG HARBOR (UHMC)		847-2661
Alton Goo (shop)		845-7732
Dockside		848-5438
UNION 76 (KAWAIHAE - RAYMOND)		1-882-7131
WALDRON STEAMSHIP		545-2466
Bill Thayer - ship agent		
PAUL WALSH		521-8404

C. QUICK REFERENCE - MISC. PARAMETERS

Cable Deployment Speed 10 m/minute

Desired Accuracy of Currents Data 2 cm/sec (or under 5 cm/sec)

Cable Touchdown Distance Behind Vessel (est.) 300 m.

FS3 Dimensions	Length Overall	83.20 m (273')
	Breadth Overall	19.80 m (246'9")
	Draught (Nominal)	5.12 m (16'10")

Kila Max Tow Speed With Pisces/Catamaran 6 kt

Surrogate Cable Weight	(Air)	11.280 KG/M
	(Ocean)	9.800 KG/M
EM Cable Weight	(Air)	0.321
(Type 7-J46RP)	(Ocean)	0.252