AD-A168 657 FORACS (FLEET OPERATIONAL READINESS ACCURACY CHECK SITE) TARGET SSRNM (SU. (U) NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON DC CHESAPEAKE. 1/1

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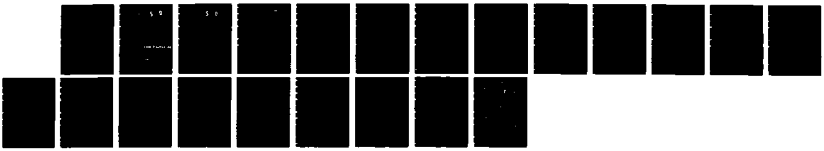

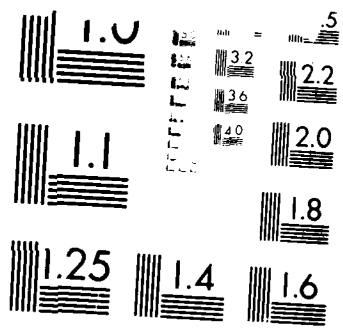
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PROJECT DOCUMENTATION REPORT

FORACS TARGET
SSRNM ARRAY INSTALLATION
AUTEC/St. Croix

November 1984

FPO-1-84(31)

Ocean Engineering

CHESAPEAKE DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
WASHINGTON NAVY YARD
WASHINGTON, DC 20374

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Unclassified
SECURITY CLASSIFICATION OF THIS PAGE

AD-A168657

REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION
Unclassified

1b. RESTRICTIVE MARKINGS

2a. SECURITY CLASSIFICATION AUTHORITY

3. DISTRIBUTION AVAILABILITY OF RE
Approved for public release;
distribution is unlimited

2b. DECLASSIFICATION/DOWNGRADING SCHEDULE

4. PERFORMING ORGANIZATION REPORT NUMBER
FPO-1-84(31)

5. MONITORING ORGANIZATION REPORT

6a. NAME OF PERFORM. ORG.
Ocean Engineering
& Construction
Project Office
CHESNAVFACENGCOM

6b. OFFICE SYM

7a. NAME OF MONITORING ORGANIZATIO

6c. ADDRESS (City, State, and Zip Code)
BLDG. 212, Washington Navy Yard
Washington, D.C. 20374-2121

7b. ADDRESS (City, State, and Zip

8a. NAME OF FUNDING ORG.

8b. OFFICE SYM

9. PROCUREMENT INSTRUMENT INDENT

8c. ADDRESS (City, State & Zip)

10. SOURCE OF FUNDING NUMBERS

PROGRAM ELEMENT #	PROJECT #	TASK #	WORK UN ACCESS

11. TITLE (Including Security Classification)
FORACS Target SSRNM Array Installation AUTEC/St. Croix: Project Documentati Report

12. PERSONAL AUTHOR(S)
Lawrence Mendlow, Bruce Schuckman & Sandra Vickstrom

13a. TYPE OF REPORT

13b. TIME COVERED FROM TO

14. DATE OF REP. (YYMMDD) 84-11

15. PAG 18

16. SUPPLEMENTARY NOTATION

17. COSATI CODES		
FIELD	GROUP	SUB-GROUP

18. SUBJECT TERMS (Continue on reverse if nec
FORACS, Arrays, Atlantic Undersea Test ar
Evaluation Center, St. Croix

19. ABSTRACT (Continue on reverse if necessary & identify by block number)
NOSC Code 6362 tasked CHESDIV FPO-1 to install two FORACS Targets at AUTEC, Andros Island, Bahamas and one FORACS Target and one SSRNM Array at the Underwater Tracking Range, St. Croix, USVI.

20. DISTRIBUTION/AVAILABILITY OF ABSTRACT
SAME AS RPT.

21. ABSTRACT SECURITY CLASSIFICATI

22a. NAME OF RESPONSIBLE INDIVIDUAL
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22b. TELEPHONE
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22c. OFFICE SYMB

DD FORM 1473, 84MAR

SECURITY CLASSIFICATION OF THIS PAG

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LIST OF ACRONYMS

CHESDIV	Chesapeake Division, Naval Facilities Engineering Command.
NOSC	Naval Ocean Systems Center.
UCT-1	Underwater Construction Team One.
APL	Applied Physics Laboratory, University of Washington.
AUTEC	Atlantic Underwater Test and Evaluation Center.
AFWTF	Atlantic Fleet Weapons Training Facility.
UTR	St. Croix Underwater Tracking Range.
DTNSRDC	David W. Taylor Naval Ship Research and Development Center.
SUPSALV	Supervisor of Salvage, Naval Sea Systems Command.
BIW	Boston Insulated Wire Company.
FORACS	Fleet Operational Readiness Accuracy Check Site.
SSRNM	Surface Ship Radiated Noise Measurement.

1.0 MANAGEMENT SUMMARY

1.1 Background

NOSC Code 6362 tasked CHESDIV FPO-1 to install two FORACS Targets at AUTEC, Andros Island, Bahamas and one FORACS Target and one SSRNM Array at the Underwater Tracking Range, St. Croix, USVI. The organizations that participated in the project were:

1) NOSC - Funding, SSRNM Equipment and ET's.

2) CHESDIV - Installation Planning, Installation Coordination, SEACON.

3) UCT-1 - Deckforce, Installation Planning.

4) APL - FORACS Equipment and Engineers, FORACS Targets Positions.

5) AUTEC - On-site Logistics.

6) AFWTF - On-site Logistics.

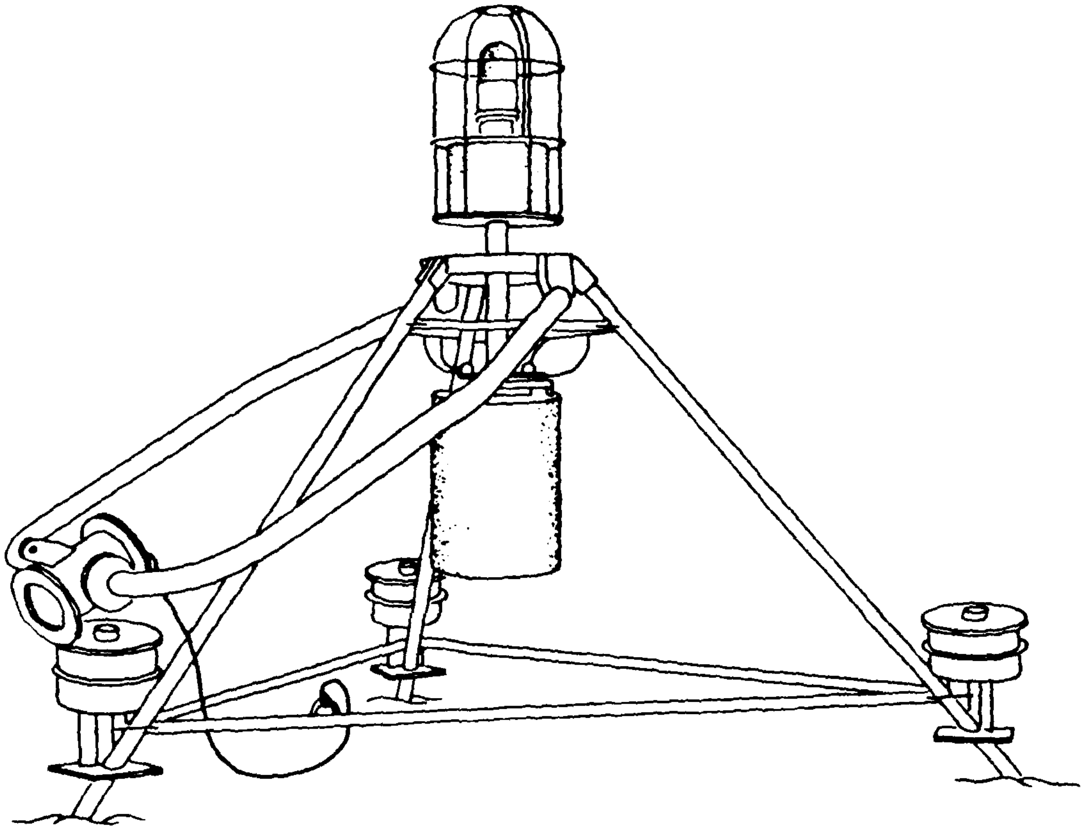
NOSC funded the project through the following documents:

N66001 83WR 00412	$30,000.00	23 JUN 1983
N66001 83RC 00097	$100,000.00	10 AUG 1983
N66001 84WR 00086	$10,000.00	4 NOV 1983
N66001 84WR 00214	$137,000.00	19 JAN 1984
N66001 84RC 00053	$78,000.00	8 FEB 1984
N66001 84WR 00391	$45,000.00	23 APR 1984
N66001 84WR 00491(Amend 1)	$4,000.00	22 MAY 1984
N66001 84RC 00094	$32,000.00	22 MAY 1984

1.2 System Description - FORACS

FORACS ranges consist of a series of radar and acoustic targets used to check the accuracy of a ship's sensors. CHESDIV was tasked to install several acoustic targets (a deep and shallow water target at AUTEC and a deep water target at St.Croix with a backup to be installed as a shallow water target at St.Croix if time permitted). See Figure 1.1 for a typical FORACS acoustic target.

Each target is separately cabled back to shore (with Simplex .057/.180 Quad Cable) and into a control panel located in the control room of the appropriate facility. CHESDIV efforts consisted of bringing the cable to the on-shore termination boxes. The connections to the termination boxes and the cabling and connections between the boxes and the control panel were carried out by the facility and APL.



FORACS Target

Figure 1.1

The targets were designed and built by APL. The target locations were selected by APL after consultation with the respective facilities. The position was not considered critical so there was no specification of accuracy in the X-Y plane.

However, depth was considered important and specifications for depth were given; for the shallow targets the depth was permitted to vary from the selected depth to 10 ft deeper than the selected depth. For the deep targets the depth was to be between 1200 and 1300 feet. However this was permitted to be varied on site with the consent of the APL engineer on board.

1.3 System Description - SSRNM

The SSRNM system is a vertical acoustic array designed to analyze the acoustic signature of a surface ship. The SSRNM array consists of a subsurface float, a Kevlar strength member, electrical cables and four hydrophones. The array was also designed to have a powered pinger on it for 3-D location on the range. The array is held in position by a concrete clump (17,000 lbs in air, 9,600 lbs in water). A specially designed cable connects the array to shore, with transformers in a junction chamber at the base of the array to insure proper signal strength/impedance. On shore is an electronics van where all the signal processing occurs. See Figure 1.2 for SSRNM Array.

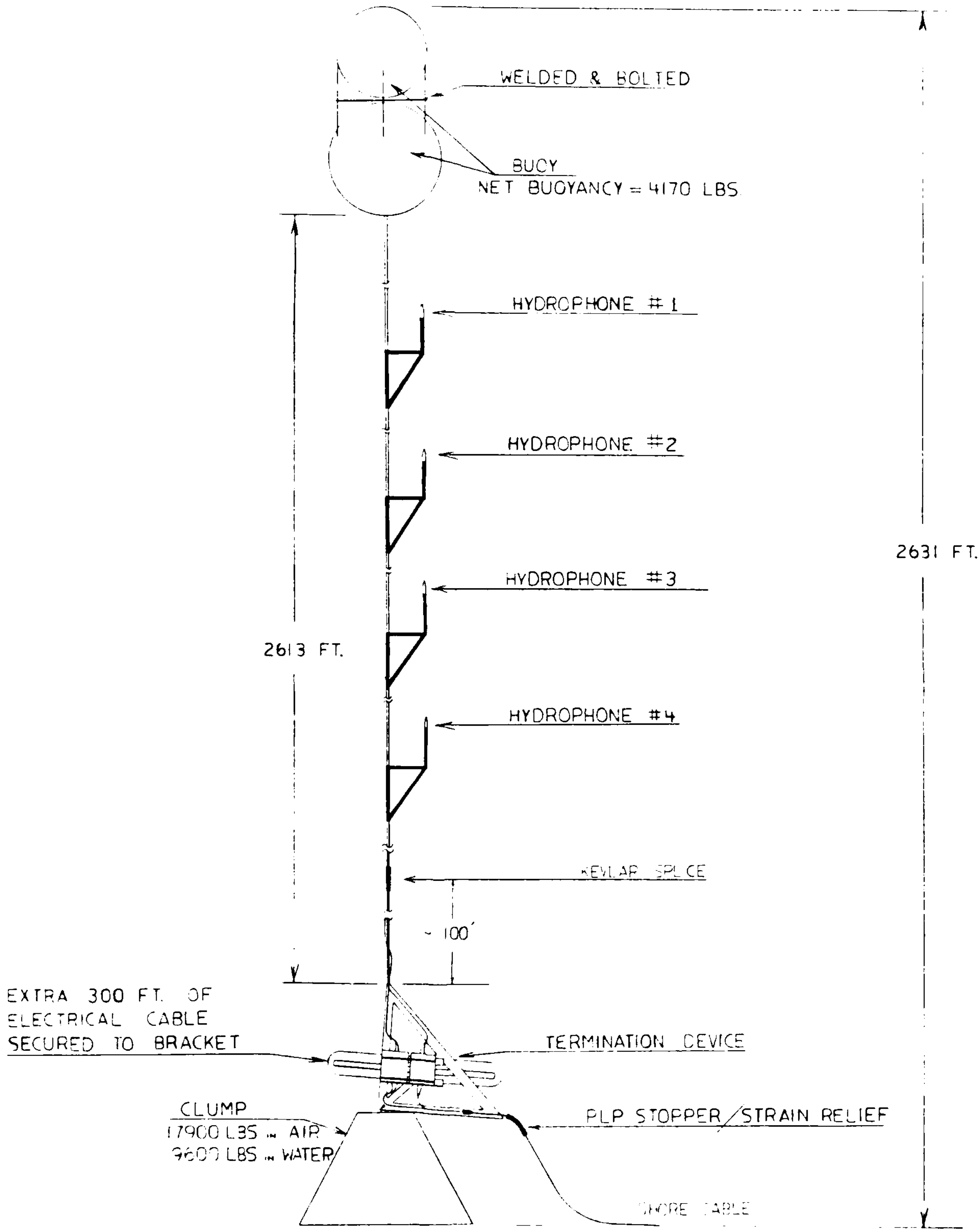
The array was designed and built by NOSC in conjunction with DTNSRDC. The location was provided by NOSC and the UTR. Once again vertical control was considered more important than horizontal control. Horizontally, a several hundred foot error was considered acceptable, but vertically, the top of the buoy had to be between a depth of 100 ft and 120 ft, based on the draft of large tankers and diver limitations.

1.4 Construction Site - AUTEC

AUTEC is located on Andros Island, Bahamas. It consists of an acoustic range, a weapon range and a FORACS range with all the support facilities to maintain the base, the ranges and all the equipment that the ranges use. The cable landing site was inside a cut in the reef permitting SEACON to approach no closer than 1 mile from shore and necessitated use of an AUTEC LCM-6 to pull the cable to shore. An existing cable trench was used to route the cable from the beach to the Command and Control building.

1.5 Construction Site - St. Croix

The St.Croix UTR under the cognizance of AFWTF, Roosevelt Roads, PR is located at Sprat Hall, 1 mile north of Frederiksted, ST.Croix, USVI.



SSRNM ARRAY

Figure 1.2

The facility overlooks the beach landing site on a steep 30 ft high bluff. The shore drops off fairly quickly, permitting SEACON to approach within 1200 ft of the shore.

1.6 Construction Planning Summary

23 Jun 83	Original tasking for FORACS/SSRNM Installation.
17 Nov 83	Dates of Installation and use of SEACON finalized.
19 Jan 84	Op order 2-84 promulgated.
20 Mar 84	Project Execution Plan - FPO-1-84(1) promulgated.
20 May 84	Addendum to PEP promulgated.
22 May 84	Op order 3-84 promulgated.

1.7 Construction Operations Summary

13-18 Feb 1984	SEACON towed from Norfolk, VA to Fort Lauderdale, FL.
19-30 Mar	SEACON and project mobilization at Fort Lauderdale, FL. The effort included the assembly of the FORACS structures, the winding of the electrical cables and the Kevlar rope onto Pengo reels, and loading the SSRNM cable in SEACON's cable tank.
31 Mar - 1 Apr	SEACON transited to AUTEC.
2 Apr	CHESDIV personnel setup Miniranger shore stations. UCT-1 and AUTEC personnel set up the beach site for hauling the cable ashore.
3-4 Apr	Installed deep water FORACS Target.
5-6 Apr	Installed shallow water FORACS Target.
7 Apr	UCT-1 and CHESDIV personnel pulled the near shore portion of the cables into position and demobilized the shore sites. SEACON departed AUTEC.
8-13 Apr	The USS PAPAGO, ATF 160, towed SEACON to NAVSTA Roosevelt Roads, PR.

13-14 Apr	Picked up the SSRNM clump and the FORACS cable for St.Croix Operations at NAVSTA Roosevelt Roads. Wound the FORACS cable on Pengo reel.
15 Apr	SEACON transited to St.Croix.
16 Apr	UCT-1 and CHESDIV personnel set up the shore site.
17 Apr	Plumbed the SSRNM site and cut the SSRNM Kevlar strength member to match the depth at the installation site. NOSC personnel installed a new socket on the Kevlar strength member.
18 Apr	Installed deep & shallow FORACS Targets.
19 Apr	Equipment failure caused loss of SSRNM clump/shore cable/junction chambers.
29 Apr	With SUPSALV personnel using Deep Drone aboard USNS MOHAWK, T-ATF 170, the clump was recovered aboard SEACON.
30 Apr	Recovered the shore cable into the SEACON's cable tank.
1 May	UCT-1 and CHESDIV personnel broke down the shore site. SEACON transited to NAVSTA Roosevelt Roads.
14-18 May	BIW reterminated the SSRNM cable on board SEACON.
23-25 May	SEACON mobilized at NAVSTA Roosevelt Roads.
25-26 May	SEACON transited to St.Croix.
26 May	Set up the shore site.
27-28 May	Installed the SSRNM array.
28 May	Demobilized the shore site.
28-29 May	SEACON transited to NAVSTA Roosevelt Roads, PR.
30 May	Demobilized SEACON

2.0 LOCATION DETAILS

2.1 Geographical Data, Site Plan & System Element Locations

AUTEC is located at Andros Island Bahamas. The FORACS Range uses a local grid with the North Tower as the origin and the Y axis at an azimuth of 305.9°. CHESDIV chose to use a grid system based on true north and selected on old AUTEC construction grid. In this system the location of the North Tower is (11430 X, 47625 Y). To convert from the FORACS grid to this grid system use the following formulas:

$$X_{cg} = X_f \, Cos(305.9) - Y_f \, Sin(305.9) + 11430$$
$$Y_{cg} = X_f \, Sin(305.9) + Y_f \, Cos(305.9) + 47625$$

To convert from the construction grid to the FORACS grid use the following formulas:

$$X_f = (X_{cg} - 11430) \, Cos(305.9) + (Y_{cg} - 47625) \, Sin(305.9)$$
$$Y_f = (X_{cg} - 11430) \, Sin(305.9) + (Y_{cg} - 47625) \, Cos(305.9)$$

The conversion from latitude/longitude to FORACS grid is done by the range. The North Tower and the Instrument Tower were used as miniranger transponder stations. The location of the miniranger stations and installed targets are shown in Table 2.1 and Figure 2.1.

The St.Croix Underwater Tracking Range is located on the west side of St.Croix, north of Frederiksted. The range uses a local grid based on a rotation and translation of UTM coordinates. This was the system used for this project. Conversion between latitude/longitude and the grid system is accomplished by the range. Sprat Hall and the Coast Guard Light at the foot of Frederiksted Pier were used as miniranger shore transponder sites. The locations of the miniranger sites, the FORACS targets and the SSRNM array system are shown in Table 2.2 and Figure 2.2.

3.0 INSTALLATION DETAILS

3.1 Installation Details/Comparison with Specifications

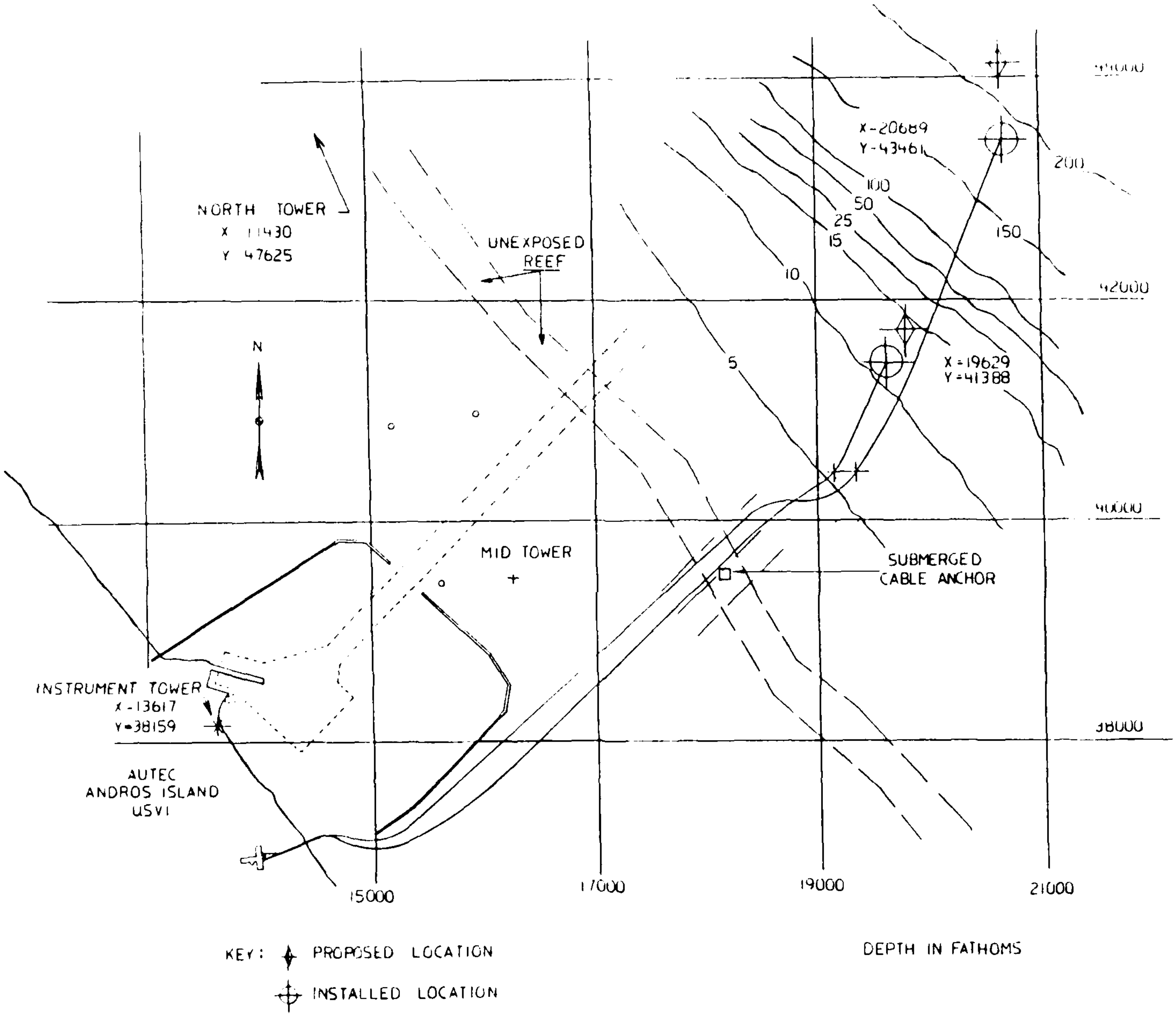
The FORACS target was a package provided by APL and installation went as planned. No changes in the design were required. However, there was a break in the cable during the installation of the shallow FORACS target at AUTEC. The splice to reconnect the cable is in the cable trench well on shore. What was learned from this experience is that the shallow FORACS targets are diver repairable. By simply removing the bolts from the chamber flange connection and disconnecting the underwater mateable connectors, the chamber can be brought to the surface. All location changes were as a result of water depth requirements and agreed to by APL. A comparison between the planned and the installed locations is shown in Table 2.1.

SITE	PLANNED LOCATION		CONSTRUCTION GRID INSTALLED LOCATION		FORACS GRID INSTALLED LOCATION	
	X (E)	Y (N)	X	Y	X	Y
NORTH TOWER	11,430	47,625	11,430	47,625	0	0
INSTRUMENT TOWER	13,617	38,159	13,617	38,159	10,882	3,862
DEEP FORACS TARGET	20,675	44,120	20,689	43,461	13,069	2,191
HOLD POINT FOR DEEP LFTS	19,000	40,460	19,360	40,630	14,344	3,228
SHALLOW FORACS TARGET	19,800	41,720	19,629	41,388	13,916	2,945
HOLD POINT FOR SHALLOW LFTS	19,000	40,460	19,167	40,394	14,369	3,310

Note: All coordinates are in feet.

AUTEC INSTALLED LOCATIONS

Table 2.1



AUTEC Installations

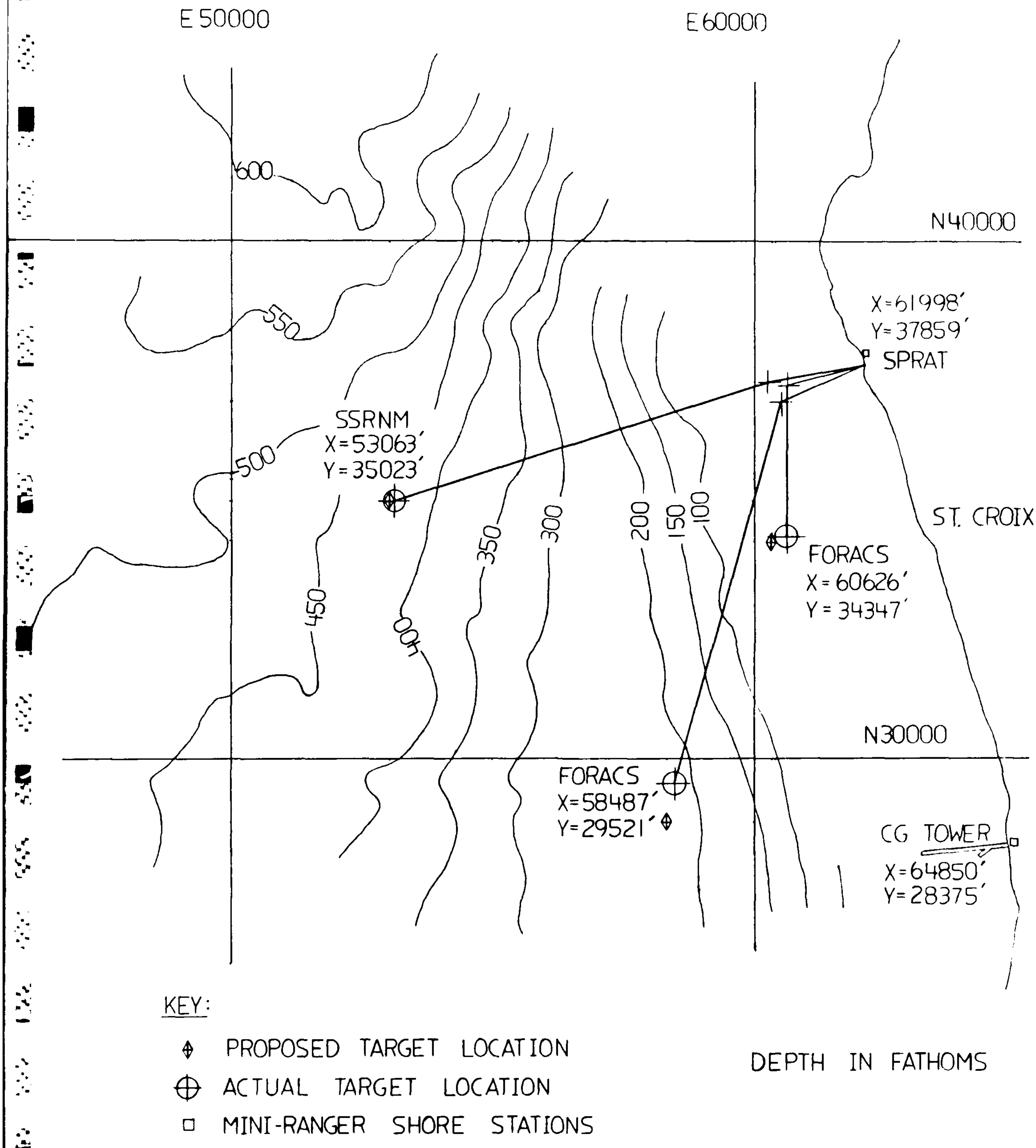
Figure 2.1

SITE	PLANNED LOCATION X (E)	Y (N)	INSTALLED LOCATION X	Y
SPRAT	61,998	37,859	61,998	37,859
COAST GUARD LIGHT	64,850	28,375	64,850	28,375
DEEP FORACS TARGET	58,302	28,774	58,487	29,521
HOLD POINT FOR DEEP LFTS	60,400	36,975	60,610	36,985
SHALLOW FORACS TARGET	60,334	34,225	60,584	34,311
HOLD POINT FOR SHALLOW LFTS	60,400	36,975	60,722	37,290
HOLD POINT FOR SSRNM ARRAY	60,279	37,333	60,623	37,054
SSRNM ARRAY	52,986	35,029	53,063	35,023

Note: All coordinates are in feet.

ST. CROIX INSTALLED LOCATIONS

Table 2.2



St. Croix Installations

Figure 2.2

The SSRNM array, see Figure 1.2, was changed from the original design due to the following operational and installation considerations:

A. The original design was based on a 3000 ft water depth, the selected site was only 2700 ft, and required that 300 ft of Kevlar strength member be cut off and the Kevlar reterminated.

B. The triangular termination device was modified to hold the extra electrical array cable (300 ft) and provide a better strain relief system. See Figure 3.1.

C. Due to the break in the Kevlar strength member a splice between two Kevlar lengths exists about 100 ft above the clump.

D. While attempting to install the pinger, the back plate of the support bracket was lost over the side. No spare was available so the pinger was not installed. If needed divers can install a new pinger, but depth capabilities to 200 ft will be required by the divers used because the pinger pigtail came up approximately 50 ft short of the bottom of the buoy and not the 5 ft as planned.

E. The double buoy system was welded together as well as bolted.

F. The location of the SSRNM is off by 77 ft to the east.

G. The depth of the top of buoy was measured by diver at 142 ft, 28 ft deeper than measured by the lowering line during the installation. The obvious answer as to why the depth is different than when plumbed and measured is due to the location difference. However this does not explain why the bottom of the buoy measured 122 ft deep during installation and 150 ft deep the next day. This is due to the stretch of the Kevlar while supporting the 9,600 lb weight less the 4,200 lb buoyancy from the float holding up the array. At 1% stretch, this amounts to 26 feet which is close to the 28 ft observed.

4.0 RECOMMENDATIONS FOR FUTURE SSRNM INSTALLATIONS

1. All components should be assembled and pressure tested and electronically tested prior to installation operations. The strength member should be marked for hydrophone locations not just length indications.

2. All components should be designed to take installation loads not just installed loads.

3. When depth is as critical as the specifications stated, a better method of placing the array at the desired depth should be developed. This may require a redesign of the array itself, such as using a two-point spread moor rather than the single point moor that was installed.

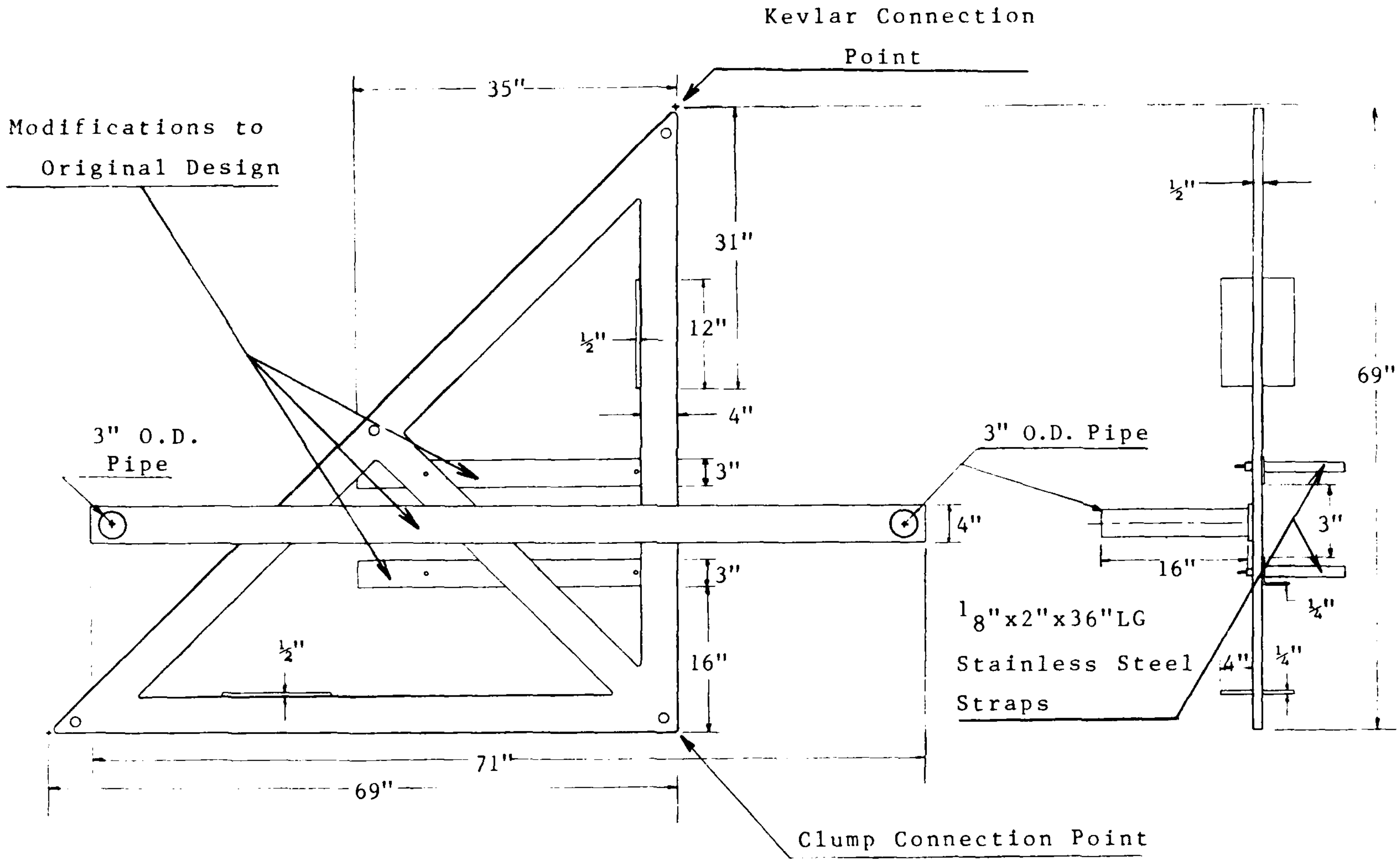


Figure 3.1 - SSRNM Termination Device

4. For all ocean operations, have spares for everything, especially small pieces that are being handled over the side of the vessel.

5. Mark length of electrical cable (every 100 ft).

6. The array electrical cable length should incorporate a given percentage of slack in order to accommodate a tension free connection to the mechanical cable.

7. Mark length of shore cable (every 1000 ft or .1 NM).

8. Reduce in-air weight/size of clump to make installation handling easier.

END

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