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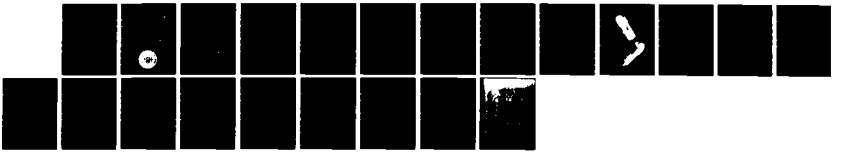

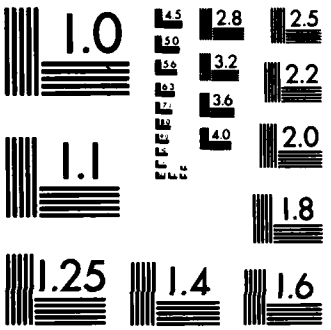

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DEPARTMENT OF THE NAVY
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PANAMA CITY, FLORIDA 32407

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EVALUATION OF THE EFCOM UB/UDR-54 MARK TRAK UNDERWATER LOCATING SYSTEM

EDWARD S. MORRISON

JULY 1983

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UNDERWAER BEACON
UNDERWATER RECEIVER

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

In June 1982, the EFCOM UB/UDR-54 MARK TRAK underwater locating system was evaluated by the Navy Experimental Diving Unit (NEDU). The purpose was to determine the systems suitability for U.S. Navy diver use, in providing a low cost, easy to use and maintain alternative to marking and tracking units currently used by the fleet.

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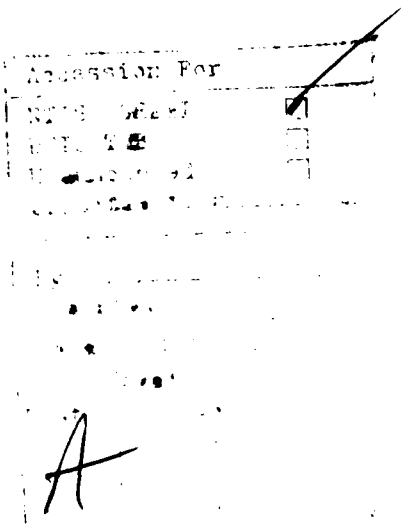
Table of Contents



Glossary

auto	automatic
datum	central point
FPM	feet-per-minute
FSW	feet-of-seawater
LED	light emitting diode
mi.	mile
naut.	nautical
UB	underwater beacon
UDR	underwater directional receiver

Abstract

In June 1982, the EFCOM UB/UDR-54 MARK TRAK underwater locating system was evaluated by the Navy Experimental Diving Unit (NEDU). The purpose was to determine the systems suitability for U.S. Navy diver use, in providing a low cost, easy to use and maintain alternative to marking and tracking units currently used by the fleet.

The EFCOM MARK TRAK proved to be a sound and reliable system requiring little diver training before use. Human engineering aspects of the MARK TRAK were good and no material failures were encountered during the test. The units entirely fulfilled manufacturers specifications. The EFCOM UB/UDR-54 MARK TRAK underwater locating system is considered to be an effective system of marking and tracking an underwater object for the U.S. Navy diver.

I. INTRODUCTION

In June 1982, NEDU conducted a manned open-water evaluation of the EFCOM UB/UDR-54 MARK TRAK underwater locating system (EFCOM Communications Systems, Bardeen Avenue, Irving, California 92715). Testing was conducted to determine the systems effectiveness and suitability for U.S. Navy diver use in providing a low cost, easily maintainable, less training alternative to units currently in use by the fleet. The units were evaluated for durability, ease of operation, and effectiveness with respect to object marking and tracking.

II. EQUIPMENT DESCRIPTION

A. General. The EFCOM UB/UDR-54 MARK TRAK underwater locating system (Figure 1) is made up of two components: a marker beacon and a hand-held receiver. The beacon transmits pulses at regular intervals which are then detected by the hand-held receiver. A solid state lamp on the receiver flashes each time a pulse is received when pointed in the direction of the beacon. Manufacturers specifications are listed in TABLE 1.

B. Component Description

1. UB-54 Underwater Beacon: The beacon transmits on a frequency of 54 Khz and has two pulse rate settings: fast and slow setting is achieved by turning a marked, notched, rotational collar to the desired position against a pointer.

2. UB-54 Underwater Directional Receiver: The receiver works on a 54 Khz return pulse transmitted by the UB-54 beacon. Each time a pulse is received, a red LED on the receiver flashes. If the UB-54 beacon is set on fast pulse the LED will flash twice per second, and when set on slow pulse, will flash once a second. The receiver has three settings: OFF, AUTO and HOLD. Setting is achieved by rotating a notched collar to the desired position against a pointer. In the AUTO position the directional receiver receives the signal in a 60° arc. When the transmitting beacon is acquired the lamp on top flashes in accordance with the set beacon transmitting pulse. Within 20 seconds of holding the beacon pulse, the beam width narrows to 10°. Searching then may continue in AUTO or a switch made to the HOLD position. In the hold position the receiving angle is narrowed to 5°, which facilitates a more accurate approach to the target. While in the HOLD position the diver can lay the beacon down and attend to equipment adjustment and the beacon will remain set on a 5° beam angle. A switch from HOLD to AUTO immediately initiates a return to a reception angle of 60°.

III. TEST PROCEDURE

A. Suitability Tests

1. Durability Test. Throughout testing the unit was assessed in its capability to withstand the usage and hazards associated in deploying it from a small craft.

FIGURE 1

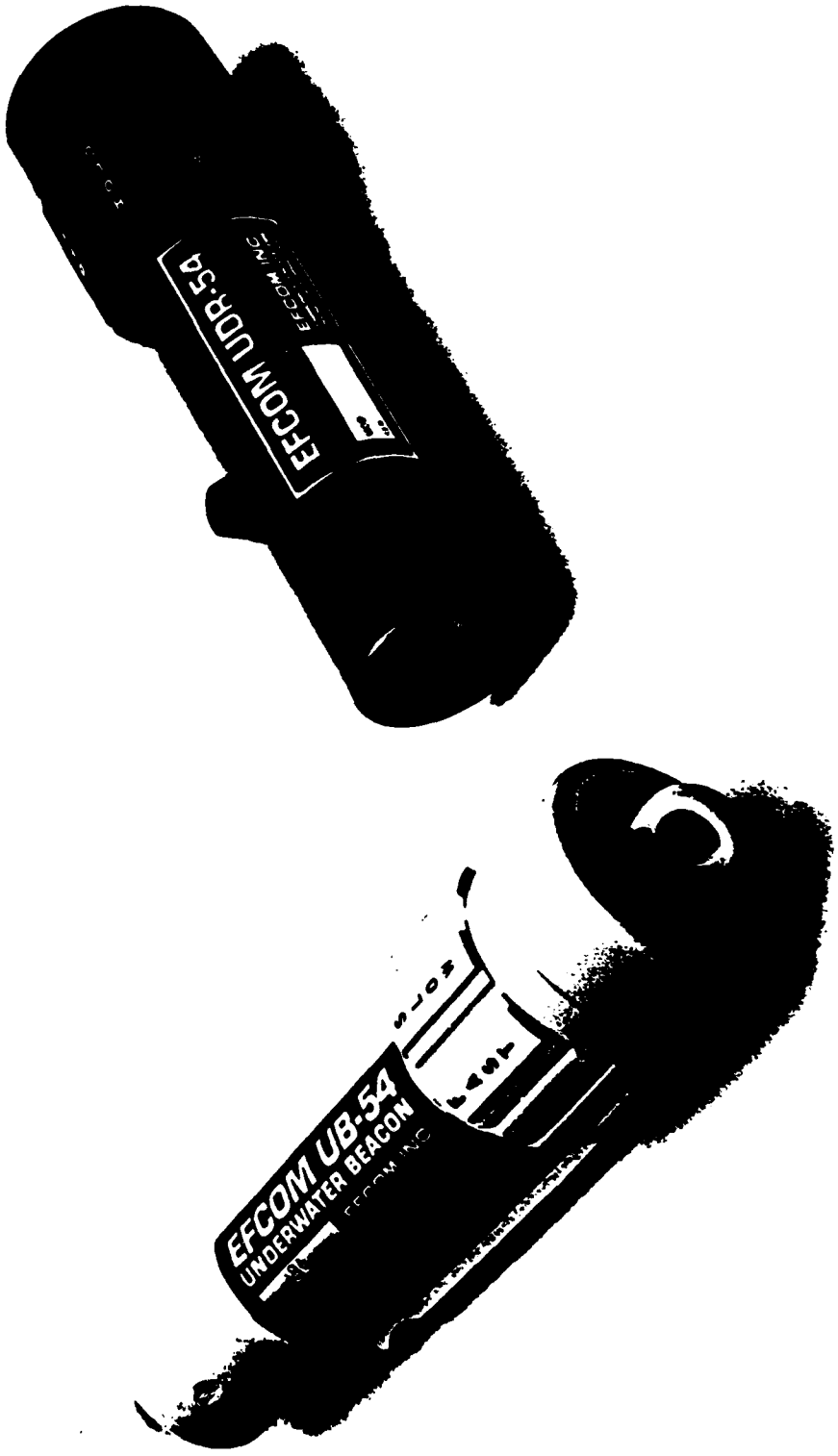

EFCOM UDR-54
EFCOM INC
EFCOM UB-54
UNDERWATER BEACON
EFCOM INC

TABLE 1

MANUFACTURERS SPECIFICATIONS

A. UB-54 UNDERWATER BEACON

Frequency	54 Khz
Range	Up to 984 FT (300 m)
Depth of operation	Tested to 984 FT - (300 m)
Radiation pattern	0 Min Directional
Power source	9-V alkaline transistor radio type
Pulse rate	Slow - 1 pulse per second
	Fast - 2 pulses per second
Battery life	Slow pulse - 16 weeks continuous use
	Fast pulse - 8 weeks continuous use
Operating temperature	-2C to +50C - (35.6F to + 122F)
Weight in air	280 grams (10 oz) (2800 n)
Weight in water	84 grams (3 oz)
Size	Length 17 cm (6.75 in)
	Diameter 5 cm (2 in)
Materials	High impact holicarbonate

B. UDR-54 UNDERWATER DIRECTIONAL RECEIVER

Frequency	54 Khz
Range	Up to 980 FT
Beaming accuracy	Automatic Mode $\pm$ 10°
	Manual (Hold) $\pm$ 5°
Indicator	Highly visible light emmiting diode (LED)
Depth of operation	Tested to 984 FT (300 m)
Power source	9-V alkaline transistor radio type battery
Battery life	36 hrs continuous use
Operating temperature	-2C to +50C
Weight in air	280 grams (10 oz)
Size	Length - 17 cm (6.75 in)
	Diameter - 5 cm (2 in)
Materials	High impact holicarbonate

2. Human Factors Test. During open water dives human engineering factors were evaluated to ensure diver compatibility and use. APPENDIX A gives a sample of the evaluation form used during testing. After each dive, a human factors questionnaire was completed by each diver. The questionnaire was designed to gather data on three aspects of the MARK TRAK; unit handling, target aquisition and tracking, and unit durability.

B. Unmanned Test. The MARK TRAK beacon and receiver were turned on and placed in a fresh water bath and pressurized with air at 75 FPM to 984 ft in a test chamber. On reaching 984 ft the pressurization was stopped. Upon completion of a five minute interval pressurization was continued at 75 FPM to a depth of 2,220 ft. The units were held at this depth for one hour. Decompression was completed at 60 FPM.

C. Open Water Tests

1. Tracking Tests

a. Before commencing open water testing, a marked testing area was laid at a depth of 30 FSW (see APPENDIX B). The test grid was laid in order to achieve an accurately ranged area for the Diver-Subjects to work within. A MARK TRAK beacon set on fast pulse was suspended on a buoy line anchored to the bottom and placed at the datum mark on the south end of the grid, another beacon set on slow pulse was laid 900 ft to the north on the grid center line. The tests comprised of three phases.

(1) Target Acquisition and Tracking: Two divers with MARK TRAK receivers were each given a target beacon to find, and deployed separately at the east end of the grid. On locating their first targets, the divers were then to search for and locate the beacon farthest from them (900 ft) and swim to it.

(2) Diver Tracking from a Boat: The MARK TRAK was used from a small boat to keep track of a Diver-Subject.

(3) Boat Tracking by a Diver: A beacon was used by a diver to locate and remain within range of the dive boat anchored close to the grid datum mark.

2. Beacon Battery Life Test. During the test period, a MARK TRAK beacon was left transmitting at the datum mark on the south end of the grid after each days diving and all surface buoys marking the area of the grid removed. The MARK TRAK System was used to relocate the grid each day.

3. Range Test. A long range run was carried out by using a receiver held just under the surface over the side of a small boat. A beacon was left suspended off the bottom at the south end of the grid. The maximum range at which a signal could be acquired and held was then determined.

IV. RESULTS AND DISCUSSION

A. Suitability Tests

1. Durability Test. During the test period the EFCOM MARK TRAK system performed without fault. There were no recorded malfunctions of beacons or receivers and they remained completely watertight. APPENDIX C Table 1 shows the hours of diver usage and hours of deployment in open water.

2. Human Factors Test. In all areas evaluated the units met with Diver-Subject approval. Manufacturers instructions on set up and use were easy to follow and understand. The simplicity of the units design leaves little room for procedural error during set up or use. Since both units utilize solid state circuitry, sealed within the units body, only the battery compartment is accessible to the user. Trouble shooting and repair should be left to the manufacturer.

The Diver-Subjects required less than one hour of in-water time to become proficient in directional receiver operation. APPENDIX C (Table 2) provides an analysis of Diver-Subject comments taken from the questionnaire form used and shown in APPENDIX A.

B. Unmanned Tests. During this test the MARK TRAK system was pressurized to its rated depth of 984 FSW. It was then pressed to a depth of 2230 FSW thus exceeding its rated depth and proving itself able to withstand a pressure of almost 1000 psi.

C. Open Water Tests

1. Tracking Tests

a. Target Acquisition. After an initial settling in period, the Diver-Subjects were able to identify their target beacon and swim to it. The test proved that if a beacon is not suspended above the sea bed, then an intermittent signal will result. To alleviate this problem further testing was carried out with the beacon suspended at least 5 ft. off the bottom.

b. Diver Tracking. During this test it was possible to effectively track a diver to and from a designated target by suspending the receiver just under the surface of the water over the side of a small boat. APPENDIX C Table 4 shows number of runs done during the test.

c. Boat Tracking. The MARK TRAK system was found useful when used by a diver to find his way back to a dive boat. In this instance the beacon was suspended underneath the boat. APPENDIX C Table 5 shows the results of this test.

2. Beacon Battery Life Tests. At the end of each days diving, a beacon was left suspended at the datum mark on the south end of the grid and used to relocate the grid prior to each days diving. The UB-54 beacon was operating continuously on the bottom for an 11 day period and continued to function throught the tests.

3. Range Tests. A range test of the MARK TRAK was carried out by suspending a beacon at the grid datum mark and steaming due South stopping every 200 yds. The beacon signal was held out to a range of 0.5 naut. mi. (1000 yds) thereby exceeding its stated range. During all phases of open water tests the units performed well and were easily deployed for use by the Diver-Subjects.

V. CONCLUSIONS

The MARK TRAK system fulfilled or exceeded the specifications of the manufacturer. Throughout its evaluation the EFCOM MARK TRAK system proved to be a reliable and effective method of marking and tracking underwater objects, requiring no maintenance and little familiarization prior to its use. Analysis of the questionnaires filled out by test subjects indicated a favorable response to this piece of equipment and its performance.

APPENDIX A

HUMAN FACTORS QUESTIONNAIRE

Sonar/Tracking Unit Used _____

Target Depth _____ FSW Target Ranges From Diver _____ Ft

Time of Dive _____ Target Moving ____ Target Stationary ____

Visibility _____ Current _____

1. Diver-Subject Comments: (Check One)

	GOOD	FAIR	POOR	OTHER
a. Sonar/Tracking Unit Grip				
b. Sonar/Tracking Unit Control				
c. Sonar/Tracking Unit Digital Readout				
d. Target Acquisition				
e. Target Tracking Ability				
f. Surface Target Tracking Ability				

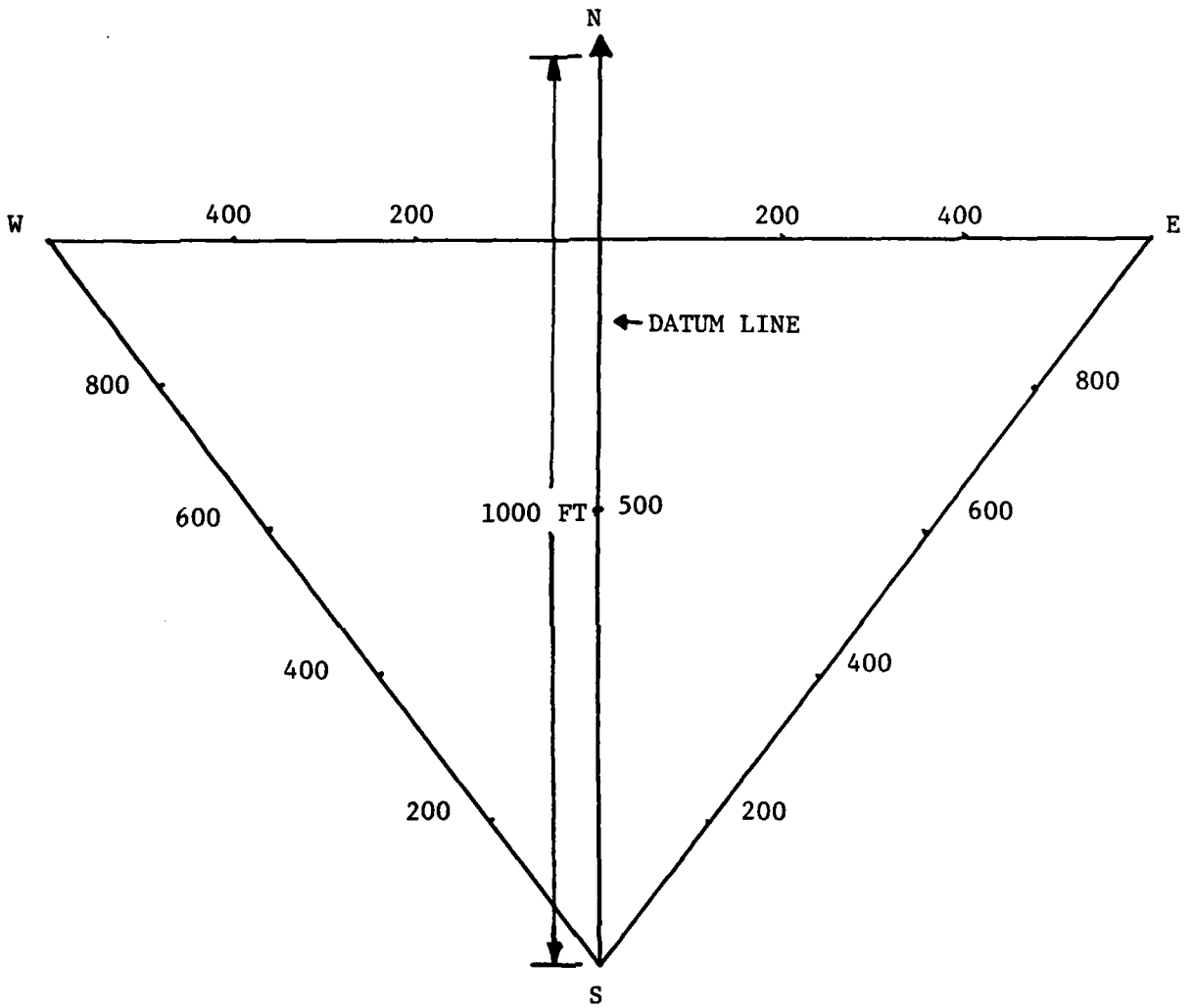
2. Diver-Subject Comments on Unit's Durability:

	YES	NO
a. Did unit maintain its watertight integrity during dive?		
b. Was there any malfunction of control switches?		
c. Was there any malfunction of battery securing devices?		

Comments on; 1. (a) - (f) and 2. (a) - (c):

APPENDIX B

SONAR TESTING GRID



1. THE GRID AREA WAS MADE OF LIGHTWEIGHT NYLON LINE MARKED EVERY 200 FT.

2. CORNERS WERE ANCHORED USING 10 LB LEAD WEIGHTS, AND MARKED USING SMALL BUOYS.

3. A SMALL BUOY LAID IN THE CENTER OF THE NORTH/SOUTH AXIS, MARKS THE CENTER OF THE GRID.

APPENDIC C

TABLE 1

HOURS OF BEACON AND RECEIVER USE

	DIVERS HOURS OF USE	RECEIVER NUMBER 1	RECEIVER NUMBER 2	BEACON NUMBER 1	BEACON NUMBER 2
TARGET ACQUISITION AND TRACKING	6	3	3	IN CONTINUOUS USE DURING TEST PERIOD	6
DIVER TRACKING AND TARGET TRACKING	5	2	2	IN CONTINUOUS USE DURING TEST PERIOD	5
DIVE BOAT TRACKING AND TARGET TRACKING	5	2	2	IN CONTINUOUS USE DURING TEST PERIOD	5
GRID LOCATION	3	2	1	IN CONTINUOUS USE DURING TEST PERIOD	3
GRID RECOVERY	1	1	0	IN CONTINUOUS USE DURING TEST PERIOD	0
TOTAL HOURS OF USE	20	10	8	240	19

APPENDIX C

TABLE 2

HUMAN FACTORS TABLE OF COMMENTS

UNIT USED	AREA OF COMMENT	DIVERS NO. 1 - 6
MARK TRAK RECEIVER	GRIP	GOOD
MARK TRAK RECEIVER	CONTROL	GOOD
MARK TRAK RECEIVER	LED VISIBILITY	GOOD
MARK TRAK RECEIVER	TARGET ACQUISITION	GOOD
MARK TRAK RECEIVER	TARGET TRACKING	GOOD
MARK TRAK RECEIVER	SURFACE TARGET TRACKING ABILITY	GOOD
MARK TRAK BEACON	SET UP PROCEDURE	GOOD

APPENDIX C

TABLE 3

TARGET ACQUISITION AND TRACKING

DIVER NO.	DESIGNATED TARGET	TARGET RANGE FROM DIVER	TARGET ACQUIRED	TARGET REACHED	SECOND TARGET	SECOND TARGET RANGE	TARGET ACQUIRED	TARGET REACHED
1	NORTH BEACON SET ON SLOW PULSE	500 FT	YES INTERMITTENT	NO	SOUTH BEACON SET ON FAST PULSE	900 FT	YES	YES
2	SOUTH BEACON SET ON FAST PULSE	500 FT	YES	YES	NORTH BEACON SET ON SLOW PULSE	900 FT	YES INTERMITTENT	NO
3	NORTH BEACON SET ON SLOW PULSE	500 FT	YES INTERMITTENT	NO	SOUTH BEACON SET ON FAST PULSE	900 FT	YES	YES
4	SOUTH BEACON	500 FT	YES	YES	NORTH BEACON	900 FT	YES INTERMITTENT	NO
5	NORTH BEACON	500 FT	YES INTERMITTENT	NO	SOUTH BEACON	900 FT	YES	YES
6	SOUTH BEACON	500 FT	YES	YES	NORTH BEACON	900 FT	YES INTERMITTENT	NO

NOTE: THE INTERMITTENT SIGNAL FROM THE NORTH BEACON WAS CAUSED BY THE BEACON BEING INCORRECTLY SUSPENDED OFF THE SEA BED AND PERIODICALLY DROPPING INTO THE SAND.

APPENDIX C

TABLE 4

DIVER TRACKING AND TARGET TRACKING RUNS

DIVER NO.	DESIGNATED TARGET AND PULSE	RANGE FROM DIVER AT START	TARGET ACQUIRED	TARGET FOUND	MAXIMUM RANGE DIVER HELD TO	RANGE OF 2ND TARGET FROM 1ST TARGET	TARGET ACQUIRED AND FOUND
1	SOUTH FAST PULSE	500 FT	YES	YES	500 FT	900 FT	YES
2	NORTH SLOW PULSE	500 FT	YES	YES	500 FT	900 FT	YES
3	SOUTH FAST PULSE	500 FT	YES	YES	500 FT	900 FT	YES
4	NORTH SLOW PULSE	500 FT	YES	YES	500 FT	900 FT	YES

APPENDIX C

TABLE 5

DIVE BOAT TRACKING AND TARGET TRACKING BY THE DIVER

DIVER NUMBER	TARGET	BEACON SETTING	RANGE FROM DIVE BOAT	DIVE BOAT BEACON SETTING	DIVE BOAT BEACON ACQUIRED	RETURNED TO DIVE BOAT
1	NORTH BEACON	FAST PULSE	600 FT	SLOW PULSE	YES	YES
2	NORTH BEACON	FAST PULSE	600 FT	SLOW PULSE	YES	YES
3	SOUTH BEACON	FAST PULSE	500 FT	SLOW PULSE	YES	YES
4	SOUTH BEACON	FAST PULSE	500 FT	SLOW PULSE	YES	YES