INTERNATIONAL PHASE OF OCEAN DRILLING (IPOD)
DEEP SEA DRILLING PROJECT
DEVELOPMENT ENGINEERING
TECHNICAL NOTE NO. 4

WIRELINE RE-ENTRY SYSTEM

SCRIPPS INSTITUTION OF OCEANOGRAPHY
UNIVERSITY OF CALIFORNIA AT SAN DIEGO
CONTRACT NSF C-482
PRIME CONTRACTOR: THE REGENTS, UNIVERSITY OF CALIFORNIA

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WIRELINE RE-ENTRY SYSTEM

Prepared for the
NATIONAL SCIENCE FOUNDATION
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Under Contract C-482

by the

UNIVERSITY OF CALIFORNIA

Scripps Institution of Oceanography
Prime Contractor for the Project

June 1984

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Deep Sea Drilling Project
Scripps Institution of Oceanography

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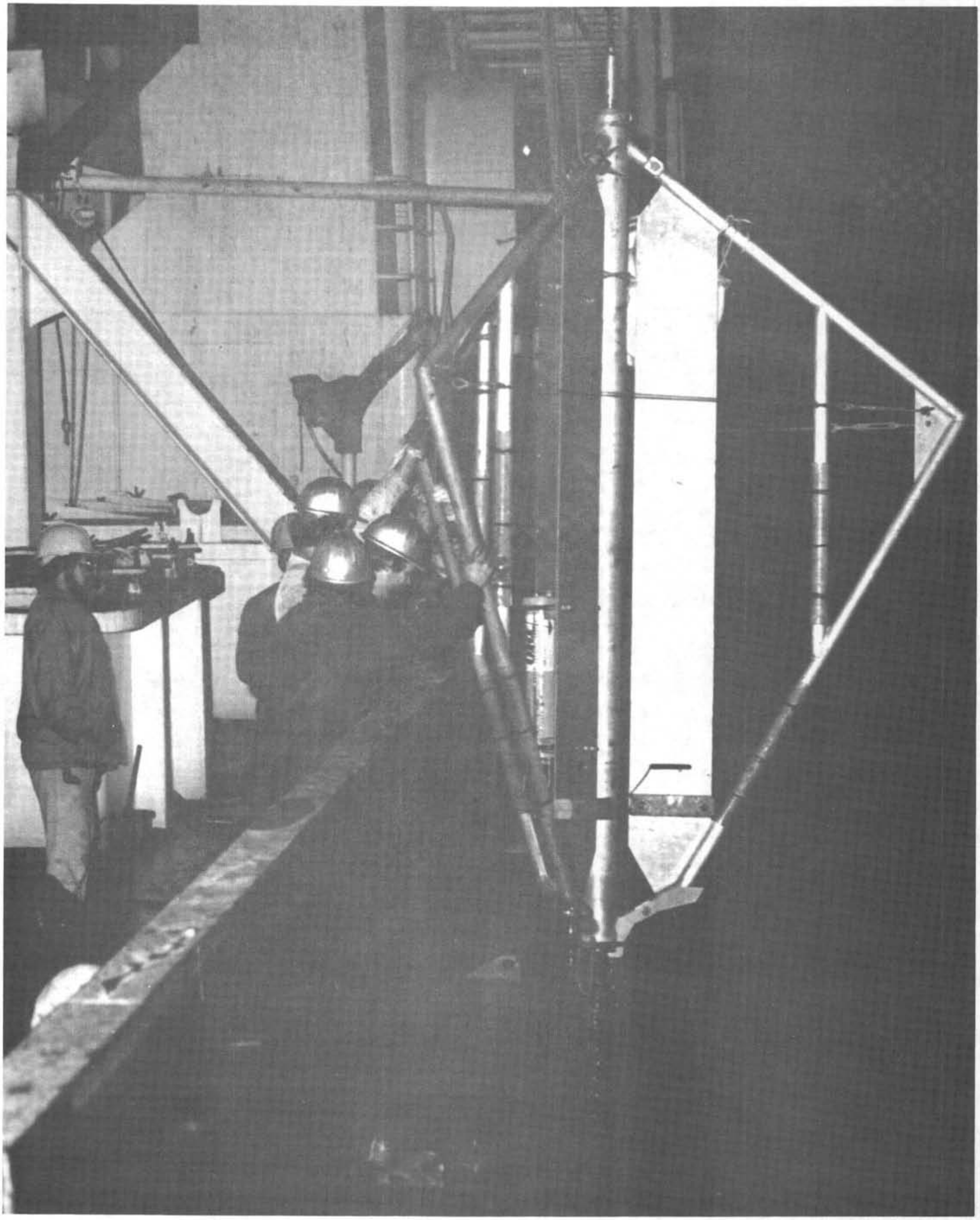

LEG 88 WIRELINE REENTRY TEST

Wireline Re-entry Test on DSDP Leg 88

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W.H.O.I. Contribution No.

Submit to: IRDSDP

Short Title: Wireline Re-entry

Introduction

For the past decade, the Glomar Challenger has routinely re-entered boreholes on the deep ocean floor with drill pipe. This innovation permitted multiple bit holes which in turn led to deeper penetration into oceanic sediments and crust. Concomitant with this technological progress was a growing scientific interest in borehole geophysical and geochemical measurements. Not surprisingly, the question arose of "wireline re-entry": can instrument packages be emplaced into boreholes in the ocean floor on standard cables from conventional research vessels?

Such a capability would expedite considerably the "in situ" science of the drilling program. 1) Routine well logging would be more cost effective because it would not be necessary to hire specialized personnel and equipment for long periods of time when they were not needed. In the past logging programs would take only two or three days on a sixty day leg. 2) Special downhole measurements legs could be scheduled with little regard for the logistical difficulties of the drill ship. Again, in the past, scientists have waited on the drill ship for up to two months in order to carry out a 12-hour experiment and interfacing with other programs on the drill ship was frequently awkward. 3) Downhole measurements programs could be planned after holes had already been drilled and hole conditions known. A number of experiments have been cancelled after considerable planning and expense because drilling was unsuccessful. 4) Long term installations of borehole instruments could be emplaced and maintained. Boreholes would no longer be just artifacts of a sampling procedure. They would become "observatories". 5) In addition, large diameter packages (up to 8") which would not normally fit in the drill pipe, could be emplaced.

In order to test the feasibility of wireline re-entry, the Deep Sea Drilling Project initiated a pilot project based on their traditional acoustic re-entry system. A frame containing navigation gear (a tracking beacon and sonar) would be suspended on the end of conventional logging cable (Figure 1). The equipment was built and we tested the system on DSDP Leg 88.

Unfortunately the scanning sonar device used to locate the re-entry cone on the sea floor did not function properly. We did, however, test the tracking of the sled relative to the Glomar Challenger to determine how well the sled could be manouvered by simply towing it with the Glomar Challenger. This paper presents a description and results of the test.

Objectives

The objectives of this test in order of importance were 1) to determine the response of the tool and cable to motion of the ship; 2) to use the EDO re-entry tool, which had been modified to include a north marker, to locate the tool relative to the ocean floor; 3) to determine the importance of tool spin; 4) to locate the drill cone; and 5) actually re-enter the cone with the re-entry tool.

When it became clear that we could not acually attempt the desired re-entry because of tool malfunction, our objectives were reduced to determining how well the passive tool could be towed to a location under the ship and to testing the feasibility of locating the tool with the on-board transponders and computing facilities.

Operations

The wireline re-entry test took place immediately after the loss of Hole 581B and prior to Hurrican Gordon. The assembly of the wireline re-entry tool commenced at 1415 (local time) on September 5. The logging cable was keel-hauled and tests of the re-entry unit were made on deck at 1845. It was apparent at this time that the north seeking capability of the tool had failed. The tool was, however, lowered to 3000 m in order to check its tracking capability with the ship's dynamic positioning computer. The tests were carried out between 2005 and 2230 and the gear was back on board at 0100 Sept. 6. Total time for the tests was 10 hours 45 minutes.

Navigation

In a wireline re-entry operation the locations of two things are required, the re-entry tool and the drill ship relative to the re-entry cone or sea floor. Since there was only one acoustic navigation device on the Glomar Challenger we alternately located the ship and the tool.

Under normal operations a reference beacon is anchored to the sea floor. Acoustic signals from this beacon are received on an array of hydrophones on the ship and the time delays of these arrivals are used to locate the ship relative to the beacon. The propulsion of the ship can be controlled automatically to maintain the ship at a fixed position relative to the sea floor beacon.

In our experiment a second beacon, similar to the seafloor beacon, but at a different frequency, was attached to the wireline re-entry tool. Navigation alternated between two modes. In the first mode the Glomar Challenger is located relative to the sea floor (a 16 kHz beacon) and in the second mode the re-entry device (a 13.5 kHz beacon) is located relative to the Glomar Challenger.

For each location measurement two types of position data were available. The most basic were the raw X, Y positions of the transponders (13.5 or 16 kHz) relative to the ship. These data were available on every update (approx.

6 secs.) but were uncorrected for ship's yaw, pitch and roll. No smoothing was applied to the data by the computer. The second type of data were the output of a low pass filter with corrections for yaw, pitch and roll. Although we felt that the corrections were important, the low pass filter amounted to a 3-5 minute average and we needed more frequent and accurate positions than this. Thus we used the raw data (which was not corrected for ship's motion) for the experiment. The Global Marine Electronics Technician generated a readout of these values at approximately 6.0 second intervals. We averaged the values ourselves, and a one-minute interval was determined empirically to give consistent and meaningful results.

In summary, approximately every 6 secs we would receive a "ping" from either the 13.5 or 16.0 kHz transponders. The time delays of the "ping" at the positioning hydrophones were used to generate the X,Y coordinates of the transponder relative to the ship. We recorded these values for one to five minute intervals on each beacon, and took one minute averages to reduce scatter caused by ship motion.

Testing Scenario

In order to check the effect of currents on the tool we decided initially to hold the ship as close as possible over the cone while lowering the tool to 3000 m. (We had originally planned to carry out similar tests at 1000 m intervals all the way to the bottom but had insufficient time.) We would then check the tool position. Because the computer could only locate one transponder at a time, the ship's position is unknown while locating the tool. While the positioning equipment was monitoring the tool there was no way to locate the ship relative to the seafloor beacon. Through trial and error we found that the ship could drift about 200 ft. (61 m) in three minutes and we tried to limit positioning windows to three minutes.

The second phase of the experiment, to move the ship a known distance and to see how the tool and cable would follow this movement, could not be carried out because of unexpected instrumental difficulties encountered.

The locations of the ship and tool, based on one minute averages are summarized in Table 1. Figures 2 and 3 display the resulting positions of the ship and tool relative to the beacon. Ship's positions were linearly interpolated between measurements and the ship locations corresponding to tool locations are indicated by circles.

Over a three minute period the tool movement appears to be independent of the ship's movement. However, over a ten to fifteen minute period the tool appears to be influenced by the ship. Tool positions are adjacent to ship's positions taken ten to fifteen minutes earlier.

The effect of any current in this area seems to be negligible at a resolution of 300 ft. (92.3 m). It is conceivable that simply lowering the tool below the ship will bring it within 500 ft. (154 m) of the cone. Since 500 ft. (154 m) is the range of the EDO re-entry tool a transponder on the sled may not be necessary.

The 2225L positions in Figure 3 display a curious phenomenon. The sequence of locations of ship and tool are numbered. For about four minutes the tool moved relatively little (approx. 50 ft.; 15.4 m) while the ship drifted 600 ft. (184.6 m). However, in the fifth minute it made a large (100 ft., 30.8 m) jump parallel to the ship's motion but in the opposite direction. This could be explained by a catenary forming in the wire as shown in Figure 4. Alternatively, it may be that the tool at the end of the 2225L track was just feeling the drift of the ship between 2210L and 2225L. The two explanations cannot be resolved from the data.

The standard deviations corresponding to the averaged locations are about 25 to 30 ft. (7.7 to 9.2 m). Most of the indicated drifts are thus significant.

Conclusions

1. At least to a depth of 3000 m the tool remains within 300 ft. (92.3 m) of the ship, almost directly below.

2. Tool motions generally lag ship's motions with a 10 to 15 min. delay time. This magnitude of delay is about a factor of two longer than that of the pipe itself. Observed tool motions are generally (about 50 ft/min., 0.26 m/sec) slower than ship's motions (about 90 ft/min, 0.46 m/sec) during this test. These values are expected to change with water depth and tool configuration.

3. Although it is possible to keep the tool within a 300 ft. (92.3 m) radius by maneuvering the ship, controlling the tool to within 10 feet (3.0 m) of a fixed point was not possible because of the poor knowledge of ship and tool locations, and the difficulty in holding the ship stationary. Even with dynamic positioning the ship's location varies ± (18.4 m) both longitudinally and transversely.

Recommendations

1. It may be possible to do this test with only the modified EDO re-entry tool (ie. no beacon on the tool). The ship's positioning system would only be used to locate the ship. The tool should be put in working order and the test redone.

2. If the ship's positioning system is to be used to locate the tool, it must be modified to have the ability to monitor two beacon locations at the same time, preferably with a display showing the location of both beacons.

3. A method for recording the data for this test should be devised that would allow detailed analysis of the results after completion. This will be important if spin of the tool is important. Without quantitative data on how fast the tool spun and in response to what forces, it will be very hard to design corrective modifications.

4. This test should take less than 18 hours to complete, and it requires only that the ship be able to hold position. Thus, it can be conducted in marginal weather when the ship cannot run pipe. We strongly recommend that the equipment for this test be made ready for the first available opportunity.

5. It should be kept in mind that the primary purpose of the wire line re-entry technique is to re-enter holes from oceanographic research vessels. Although initial testing of systems from the drilling vessel has advantages, development of a system which would be unique to the drilling vessel is meaningless. Tests from conventional research vessels should be encouraged as soon as possible. Because of the lag between ship and tool motions and the relatively poor resolution of the ship's position (even with dynamic positioning the ship moves up to 60 ft. (18.4 m) off location and the cone is only 10 ft. (3.0 m) across) propulsion on the tool itself should be seriously considered.

Acknowledgements

This project was inspired and initiated by Swede Larson, former Head of Drilling Operations at DSDP, and we regret that he was unable to see the project develop to this stage. We hope that future wireline re-entry development will be a tribute to his memory.

Captain Clarke, the officers and crew of the Glomar Challenger and the Global Marine and Scripp's electronic technicians played an essential role in carrying out the experiment and we express our gratitude to them.

Woods Hole Oceanographic Institution Contribution No. .

Table 1

WIRE LINE RE-ENTRY TEST AT 3000M

SHIP'S HEADING = 165° ALL DISTANCES IN FEET

TIME (local) 5/9/82	SHIP-BEACON RELATIVE X	Y		SHIP-TOOL RELATIVE X	Y	BEACON-TOOL RELATIVE X	Y
2027	-56.4±21.4	31.2±11.2					
2028	(-103.2	66.1	)	-47.7±6.5	40.2±4.8	55.5	-25.8
2030	-196.8±14.2	135.8±23.5					
2100:44	88.4±28.6	-30.2±17.8					
2102:14	(116.1	-87.3	)	20.6±9.9	-301.8±14.7	-97.4	-209.8
2103:42	143.8±14.2	-144.3±20.0					
2105:11	(175.8	-157.1	)	58.8±20.5	-341.2±16.2	-117.0	-184.1
2106:30	207.7±13	-169.8±13					
2108:00	(208.5	-198.4	)	100.0±34.7	-324.4±42.0	-180.5	-126.0
2119:30	37.8±15.4	21.6±19					
2121:18	(-19	+59	)	-268.5±26.5	-186.9±19	-249.5	-127.9
2122:18	(-76.6	+96	)	-308 ±11	208 ±14	-231.4	112.0
2123:18	(-134	+133	)	-338 ±13.9	-176 ±20.4	-204	43
2124:47	-199.1±20.9	170 ±20.5					
2130:33	-59.7±33.1	144.0±31.4					
2132:23	(34.7	133	)	17.4±32.7	190 · ±9	17.3	57.0
2132:23	(129	122	)	96.1±52	4.6±22	32.9	-117.4
2134:23	(223.6	111	)	194.4±25.3	16.4±10.8	-29.2	-94.6
2135:52	317.6±22	100.4±25.2					

( ) - interpolation

Figure Captions

Figure 1. Schematic diagram of the DSDP wireline re-entry system. During the Leg 88 test only the tracking beacon on the re-entry sled was operational.

Figure 2. Locations of the re-entry sled and the Glomar Challenger relative to the sea floor beacon in three intervals around 2100, 2120 and 2130 local time. The sled seems to follow the ship with a delay of about 15-20 minutes. For example, at 2120 the sled is at the same position that the ship was at 2100.

Figure 3. A similar diagram to Figure 2 for another set of times. Again the beacon locations correspond to the ship locations 15 minutes earlier. On the 2225 run the individual one minute average locations are indicated sequentially. Although the ship is moving south the sled moves north. Such behaviour can be explained by the catenary phenomena shown in Figure 4. The size of the Glomar Challenger and the size of the re-entry cone are shown to scale.

Figure 4. If the ship moves south, why does the re-entry sled move north (Figure 3)? Imagine a ship-sled configuration shown by the dashed line at 2220. As the ship moves over the sled a catenary forms as shown by the solid line at 2230. Initial pulling on the wire will move the sled left in the opposite direction to the ship.

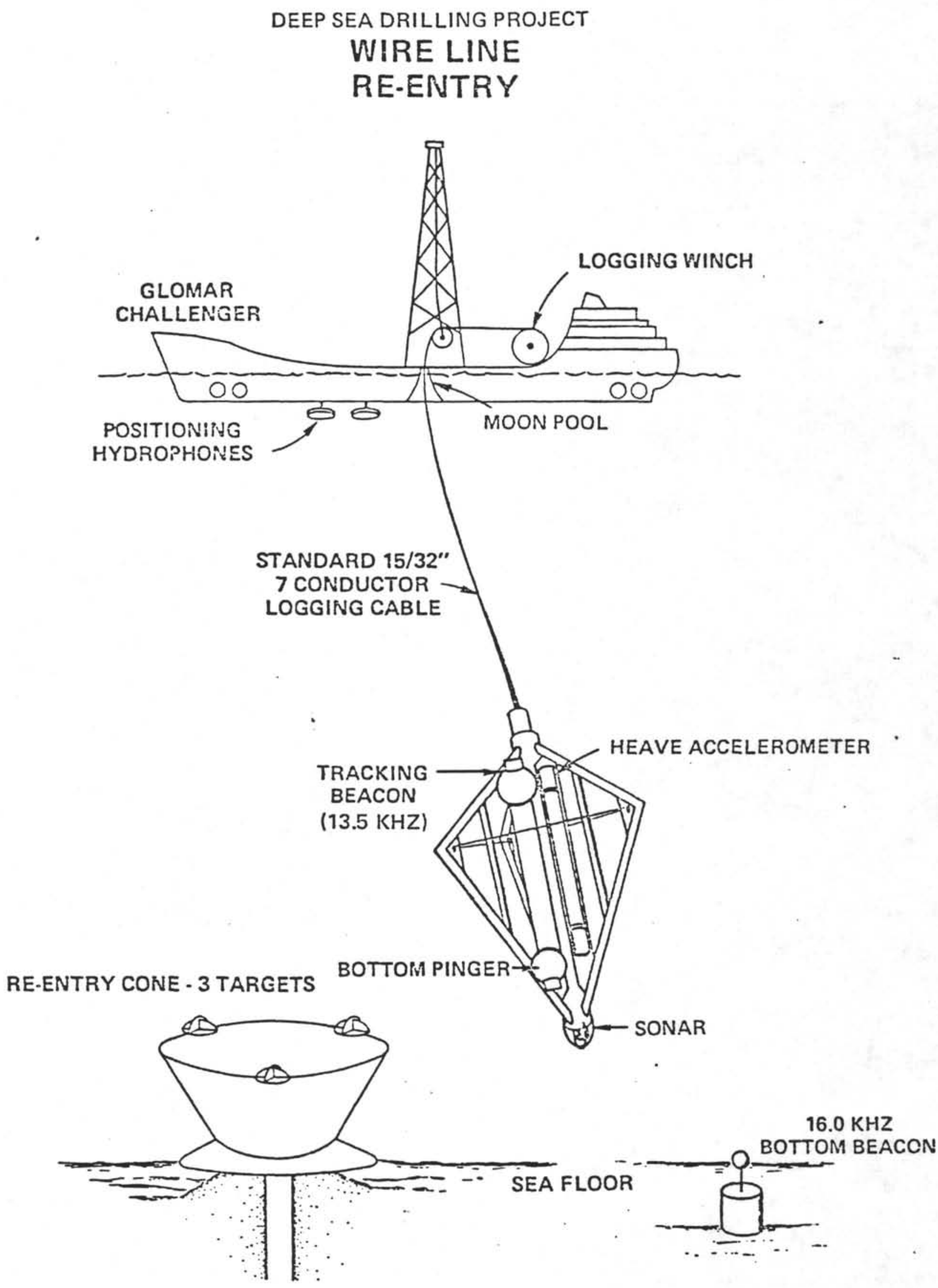


Figure 1.

FIGURE 1

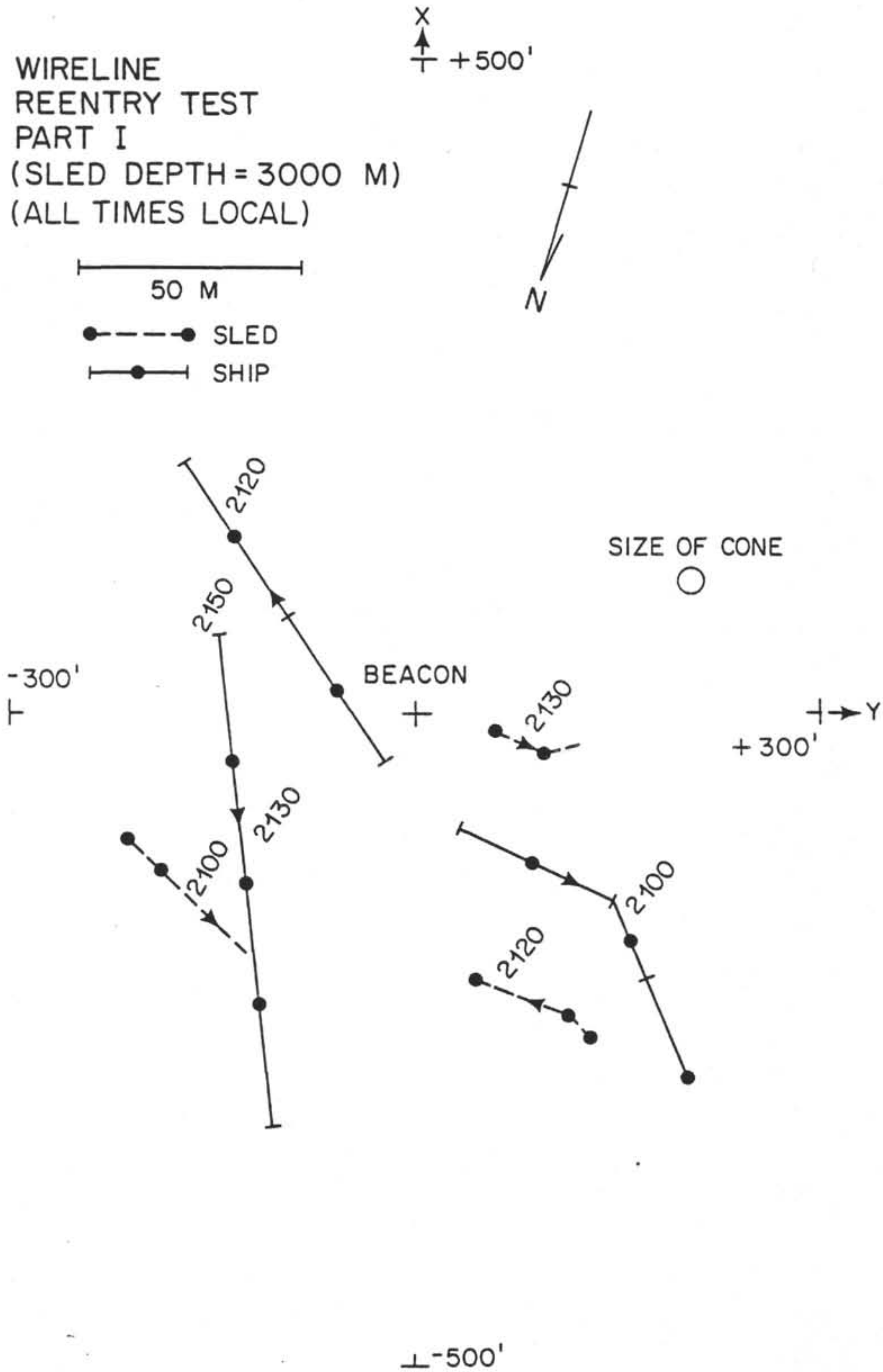

WIRELINE
REENTRY TEST
PART I
(SLED DEPTH = 3000 M)
(ALL TIMES LOCAL)
50 M
SLED
SHIP
X
+500'
N
2120
2150
SIZE OF CONE
-300'
BEACON
2130
Y
+300'
2130
2100
2100
2120
-500'

Figure 2.

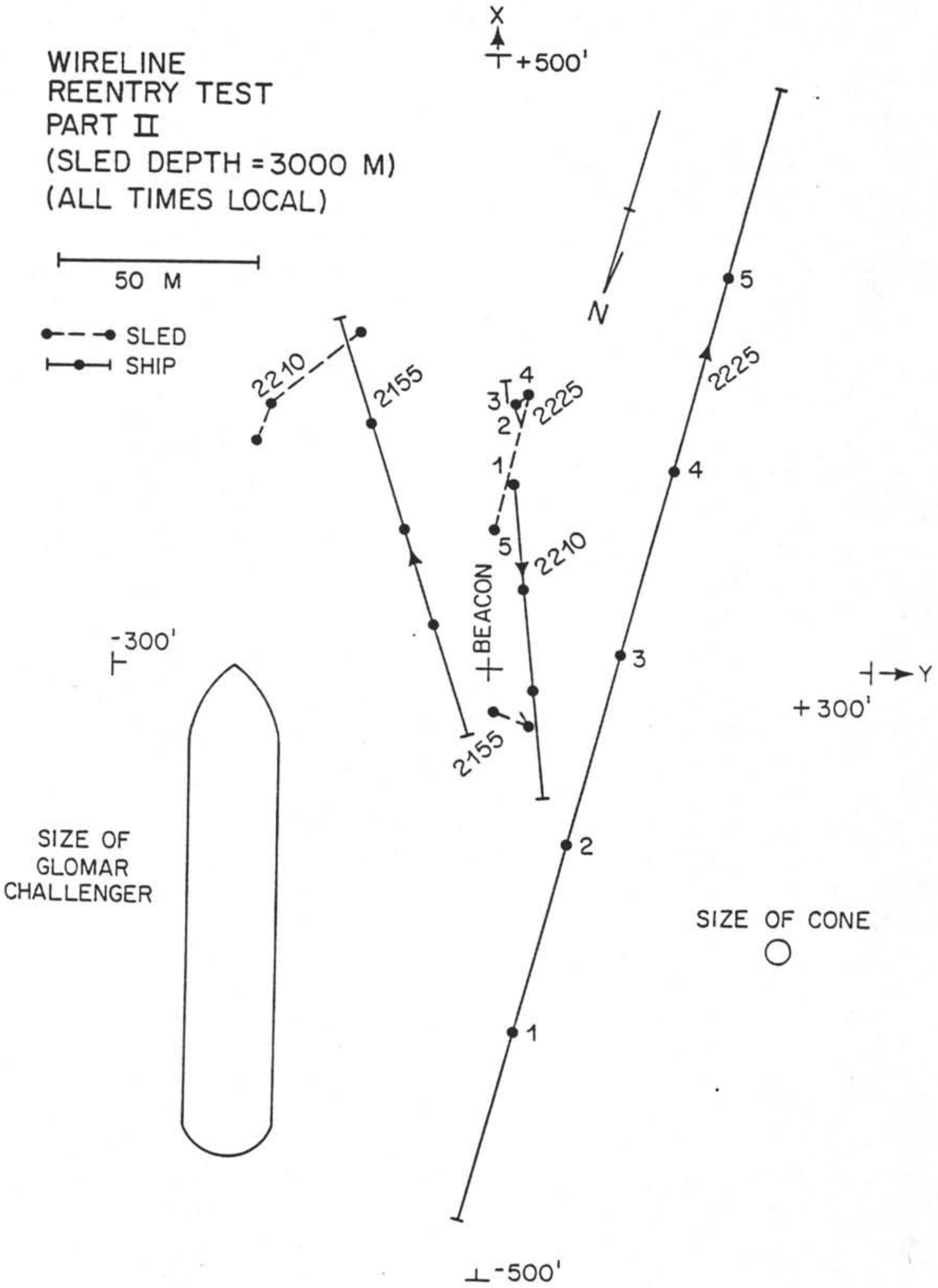

WIRELINE
REENTRY TEST
PART II
(SLED DEPTH = 3000 M)
(ALL TIMES LOCAL)
50 M
SLED
SHIP
X
+500'
-500'
-300'
+300'
Y
N
2210
2155
2225
BEACON
1
2
3
4
5
SIZE OF GLOMAR CHALLENGER
SIZE OF CONE

Figure 3.

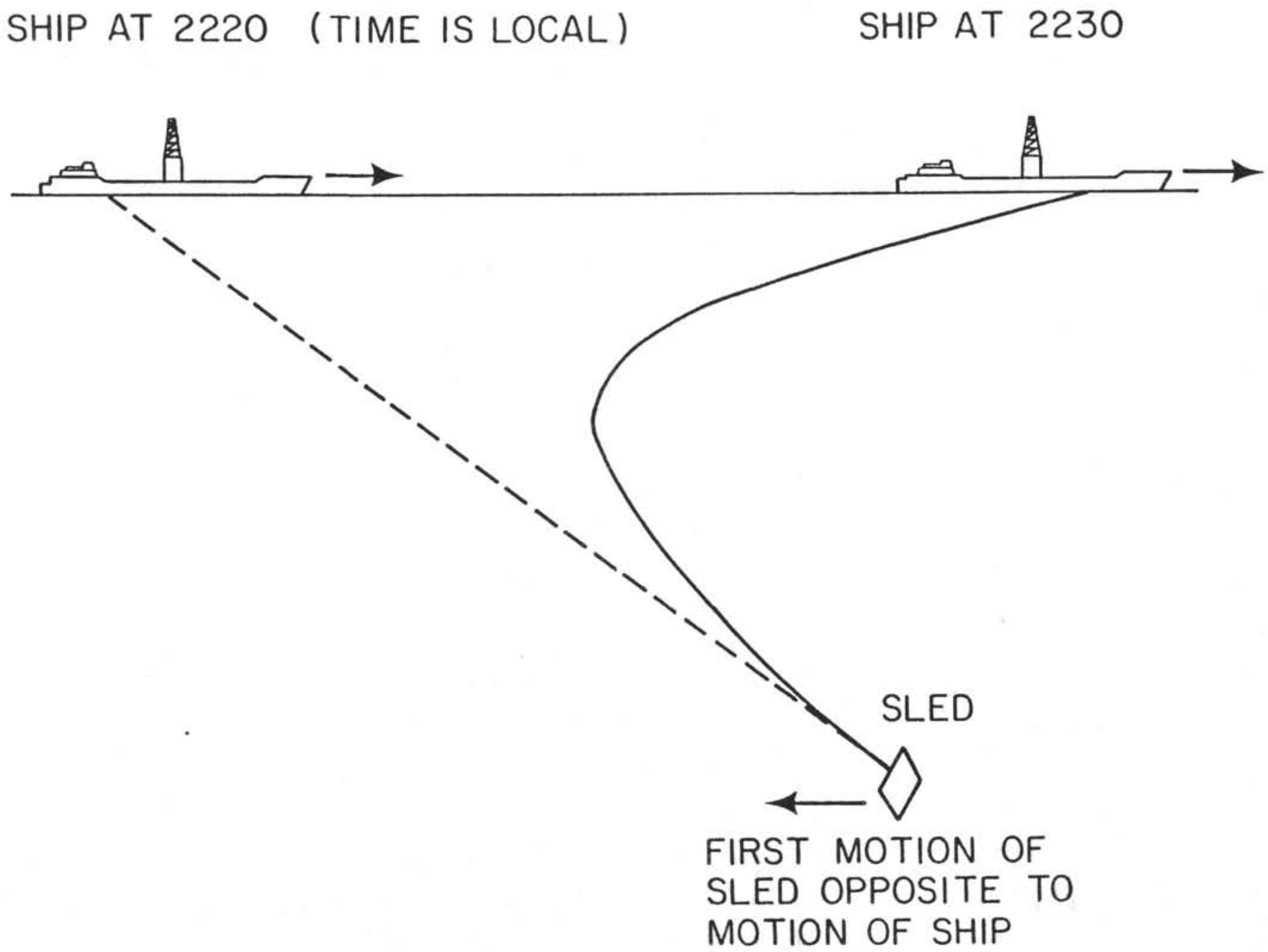

SHIP AT 2220 (TIME IS LOCAL)
SHIP AT 2230
SLED
FIRST MOTION OF
SLED OPPOSITE TO
MOTION OF SHIP

Figure 4.

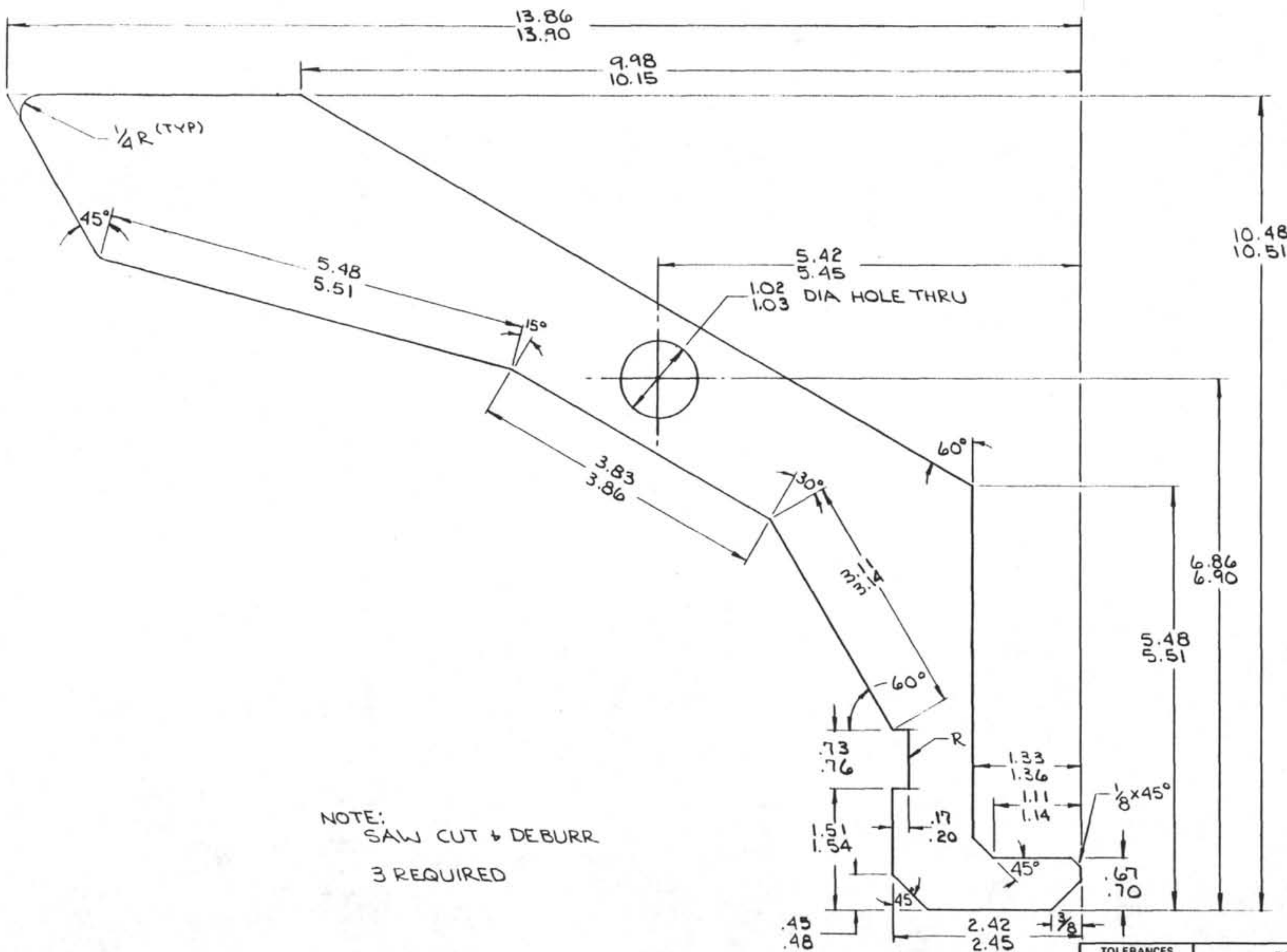
ASSEMBLY INSTRUCTIONS FOR WIRELINE
RE-ENTRY SYSTEM, DWG. NO. R-OH1117

The Wireline Re-Entry System (WRS) uses a modified EDO 516 Sonar Tool. The modification consists of the addition of a Northseeker for directional capability. This mod results in a longer (by approx. 15 inches) tool. Attach the Core Catcher Sub (OR 7040) to the 5 3/4 Threaded Guide Head (OH 1013), and attach this to the modified EDO Sonar Tool with the bolts and the Bolt Retaining Ring (OH 1014). Install Shock Washer (OH 1125), three O-Rings (Parker 2-341), and Shock Barrel (OH 1122) on EDO Tool. Install 3 1/2 Cablehead Assembly (RE 0100) on EDO Tool. Attach Shandoff Barrel to EDO Tool. Attach Bottom Cap (OH 1120) to the Tool Barrel (OH 1119). Insert EDO Tool into Tool Barrel and attach Top Cap (OH 1121). This completes the Tool Assembly as shown in OH 1117. Insert the Tool Assembly into the Fin Barrel (OH 1129) and hold in upright position. Attach three Fins (OH 1128) to the Fin Barrel using 3/4-inch bolts and the Cable Assemblies (OH 1127) - see Swg. B-041133. Attach three Release Bars (OH 1131) using the Release Bar Standoffs (OH 1132). Install two or three elastic bands (strips of motorcycle inner tube) around Release Bars. Attach Lead Pigs to fin structure for stability. Tie on ORE beacon to the completed assembly so that the pacakge may be tracked.

DRAWING LIST (MECHANICAL) FOR WIRELINE RE-ENTRY SYSTEM

PART NO.	DWG. NO.	DESCRIPTION
RE-0100	CRE-0100	3 1/2 CABLEHEAD ASSY
RE-0102	CRE-0102	CABLEHEAD
RE-0104	BRE-0104	CABLEHEAD GUARD
Re-0106	BRE-0106	SPLIT BUSHING
OH-1013	BOH-1013	5 3/4 THREADED GUIDE HEAD
OH-1014	BOH-1014	BOLT RETAINING RING
OH-1117	BOH-1117	WIRELINE RE-ENTRY ASSY
OH-1119	BOH-1119	TOOL BARREL
OH-1120	COH-1120	BOTTOM CAP
OH-1121	BOH-1121	TOP CAP
OH-1122	BOH-1122	SHOCK BARREL
OH-1123	AOH-1123	CAP, PRESSURE TEST
OH-1124	AOH-1124	STANDOFF BARREL
OH-1125	AOH-1125	SHOCK WASHER
OH-1126	BOH-1126	TEST PIPE
OH-1127	BOH-1127	CABLE ASSY
OH-1128	COH-1128	FINS
OH-1129	COH-1129	FIN BARREL
OH-1131	COH-1131	RELEASE BAR
OH-1132	AOH-1132	RELEASE BAR STANDOFF
OH-1133	BOH-1133	WIRELINE RE-ENTRY SYSTEM ASSY
	A 1768	STUB ACME INTERNAL THREAD, 4 1/2-4
	A 1769	STUB ACME EXTERNAL THREAD, 4 1/2-4
OR 7040	B OR 7040	CORE CATCHER SUB
	Sketch	ANTI-CHAFING CAP
	Sketch	LEAD PIGS
	Sketch	LAYOUT OF TRIPPING MECHANISM
	Sketch	PLUG, PRESSURE TEST
		The modified (longer) pressure housing that is used with the Wireline Re-Entry System is EDO drawing 19544-2 (The -1 is the standard housing for the EDO 516 Sonar Tool)

REVISIONS					
NO.	DESCRIPTION	DATE	BY	CH.	APR.

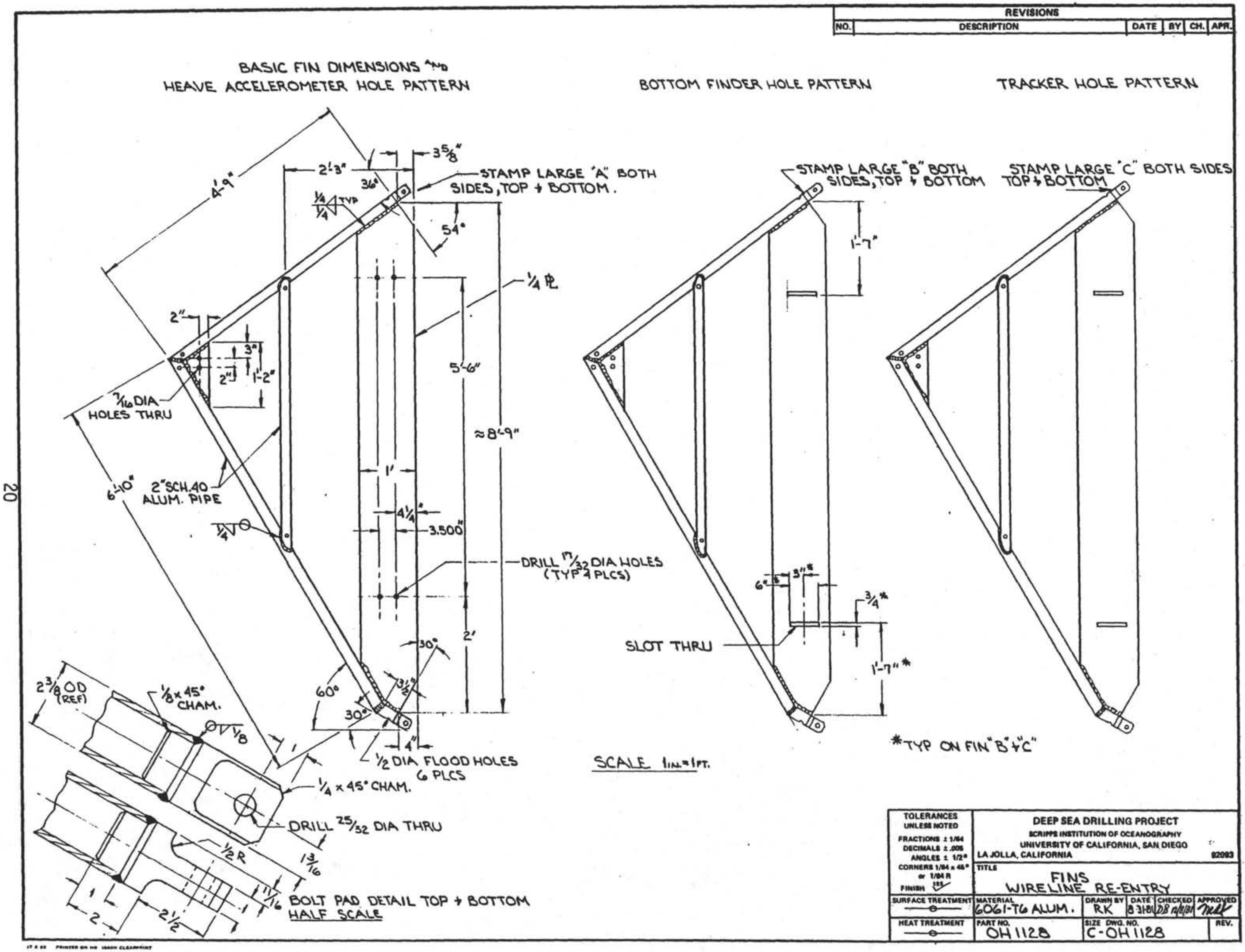


NOTE:
SAW CUT & DEBURR

3 REQUIRED

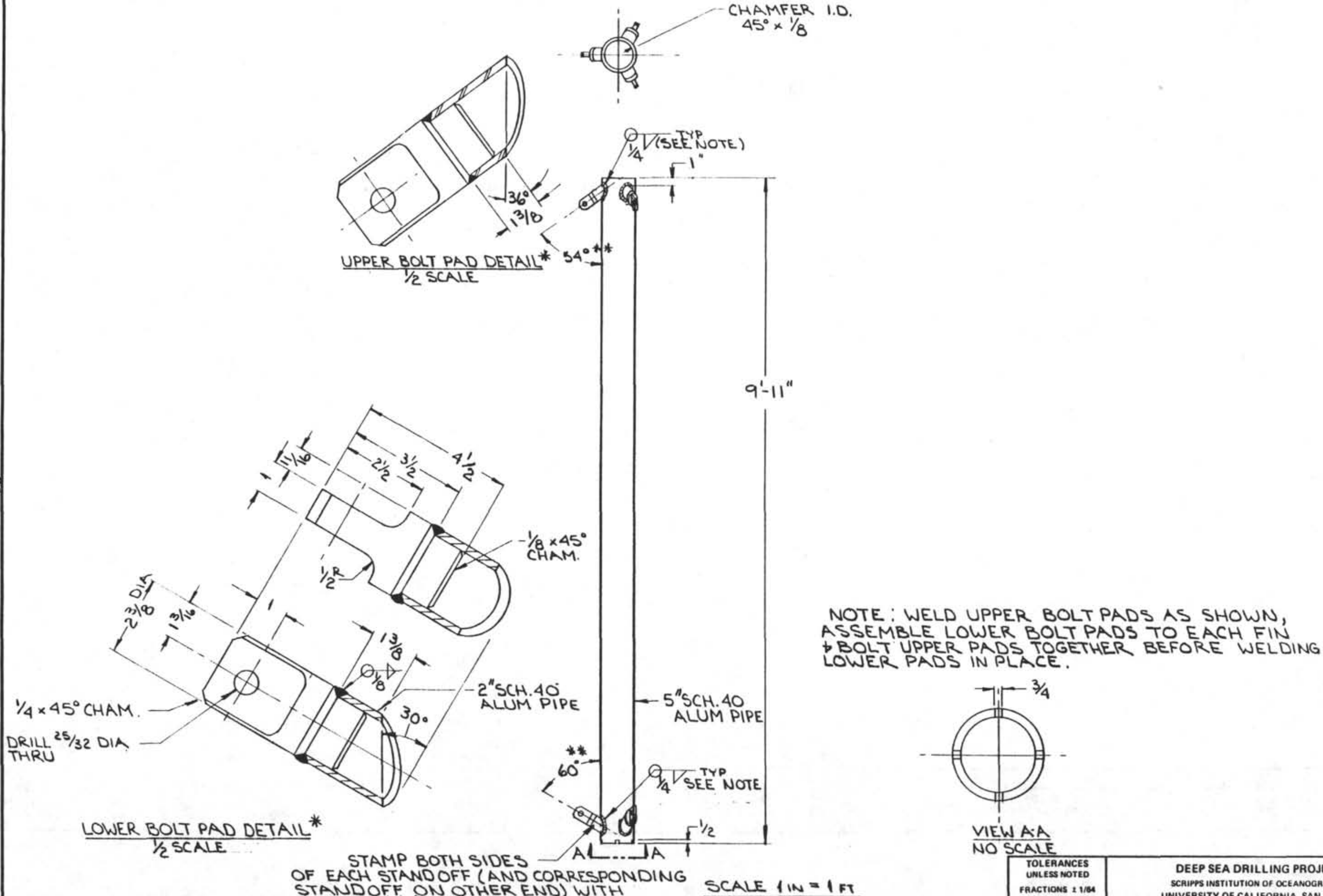
SCALE: FULL

TOLERANCES UNLESS NOTED FRACTIONS ± 1/64 DECIMALS ± .005 ANGLES ± 1/2° CORNERS 1/64 x 45° or 1/64 R FINISH 125	DEEP SEA DRILLING PROJECT SCRIPPS INSTITUTION OF OCEANOGRAPHY UNIVERSITY OF CALIFORNIA, SAN DIEGO LA JOLLA, CALIFORNIA 92093			
	TITLE RELEASE BAR WIRELINE RE-ENTRY			
SURFACE TREATMENT —	MATERIAL 1/4 6061 AL. PL	DRAWN BY RK	DATE 3/2/82	CHECKED DB 4-8-82 / APPROVED
HEAT TREATMENT —	PART NO. OH1131	SIZE DWG NO. C-OH1131-		REV. 0


REVISIONS
NO. DESCRIPTION DATE BY CH. APR.
BASIC FIN DIMENSIONS AND HEAVE ACCELEROMETER HOLE PATTERN
BOTTOM FINDER HOLE PATTERN
TRACKER HOLE PATTERN
STAMP LARGE "A" BOTH SIDES, TOP & BOTTOM.
STAMP LARGE "B" BOTH SIDES, TOP & BOTTOM
STAMP LARGE "C" BOTH SIDES TOP & BOTTOM
4'-9"
2'-3"
3 5/8"
36°
54°
1/4 TYP
1/4 PL
2"
3"
2"
1'-2"
7/16 DIA HOLES THRU
5'-6"
≈8'-9"
1'
2"SCH.40 ALUM. PIPE
6'-10"
4 1/4"
3.500"
DRILL 17/32 DIA HOLES (TYP 4 PLCS)
2'
30°
60°
30°
3 1/2"
4"
1/2 DIA FLOOD HOLES 6 PLCS
1'-7"
6"
3"
3/4*
SLOT THRU
1'-7"*
*TYP ON FIN "B" & "C"
SCALE 1IN.=1FT.
2 3/8 OD (REF)
1/8 x 45° CHAM.
1/4 x 45° CHAM.
DRILL 25/32 DIA THRU
1/2 R
1 3/16
11/16
1
2
2 1/2
BOLT PAD DETAIL TOP & BOTTOM HALF SCALE
TOLERANCES UNLESS NOTED
FRACTIONS ± 1/64
DECIMALS ± .005
ANGLES ± 1/2°
CORNERS 1/64 x 45° or 1/64 R
FINISH
SURFACE TREATMENT
HEAT TREATMENT
DEEP SEA DRILLING PROJECT
SCRIPPS INSTITUTION OF OCEANOGRAPHY
UNIVERSITY OF CALIFORNIA, SAN DIEGO
LA JOLLA, CALIFORNIA 92093
TITLE
FINS
WIRELINE RE-ENTRY
MATERIAL
6061-T6 ALUM.
DRAWN BY RK
DATE 8-31-81
CHECKED DB
APPROVED
PART NO. OH1128
SIZE DWG. NO. C-OH1128
REV.

NO.	DESCRIPTION	DATE	BY	CH.	APR.

21



*TYP BOTH ENDS EXCEPT AS NOTED.
**TYP 3 PLCS AT 120°

TOLERANCES UNLESS NOTED FRACTIONS ± 1/64 DECIMALS ± .005 ANGLES ± 1/2° CORNERS 1/64 x 45° or 1/64 R FINISH 125	DEEP SEA DRILLING PROJECT SCRIPPS INSTITUTION OF OCEANOGRAPHY UNIVERSITY OF CALIFORNIA, SAN DIEGO LA JOLLA, CALIFORNIA 92093				
	TITLE FIN BARREL WIRELINE RE-ENTRY				
SURFACE TREATMENT	MATERIAL 6061-T6 ALUM	DRAWN BY RK	DATE 9-8-81	CHECKED DB 12/8/81	APPROVED
HEAT TREATMENT	PART NO. OH 1129	SIZE DWG. NO. C-OH 1129-			REV. 0

17 x 22 PRINTED ON NO. 1000H CLEARPRINT

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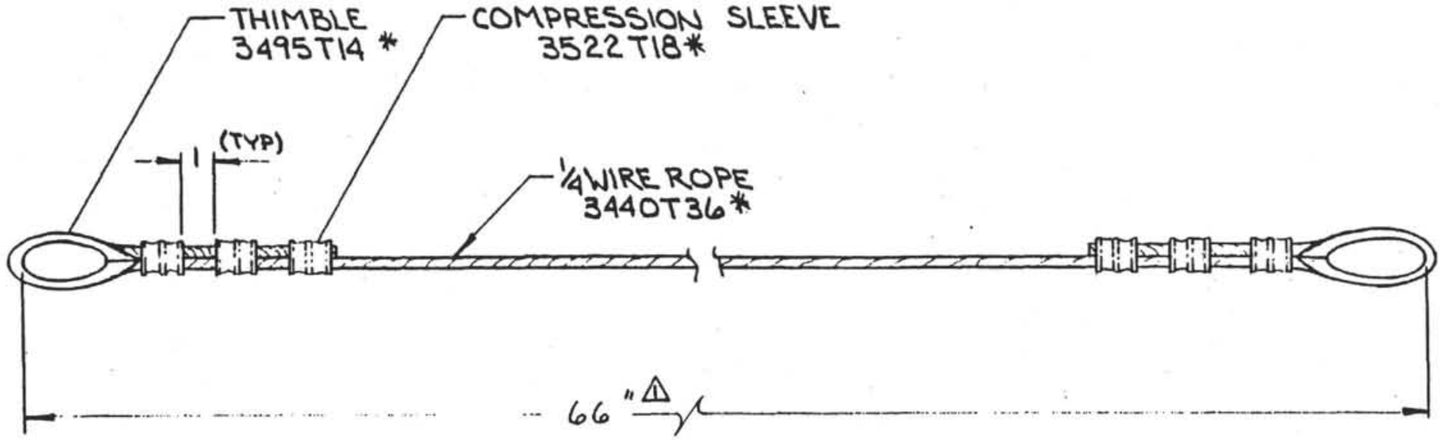

NO SCALE

*McMASTER-CARR PART NO.

22

TOLERANCES UNLESS NOTED FRACTIONS ± 1/64 DECIMALS ± .005 ANGLES ± 1/2° CORNERS 1/64 x 45° or 1/64 R FINISH 125	DEEP SEA DRILLING PROJECT SCRIPPS INSTITUTION OF OCEANOGRAPHY UNIVERSITY OF CALIFORNIA, SAN DIEGO LA JOLLA, CALIFORNIA 92093				
	TITLE CABLE ASSY WIRELINE RE-ENTRY				
SURFACE TREATMENT —⊖—	MATERIAL SEE DRAWING	DRAWN BY RK	DATE 12-6-81	CHECKED DB 12/8/81	APPROVED MAK
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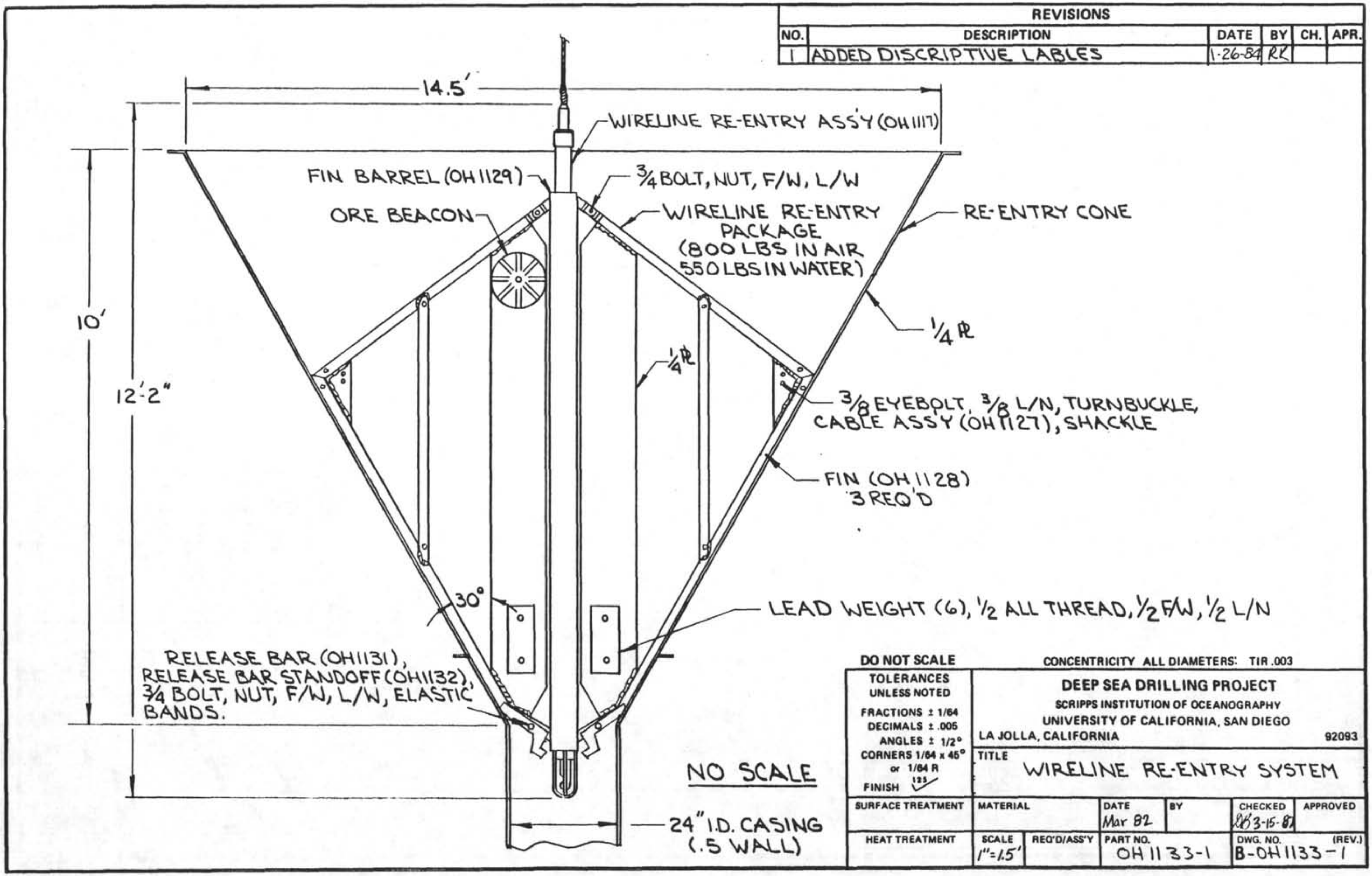
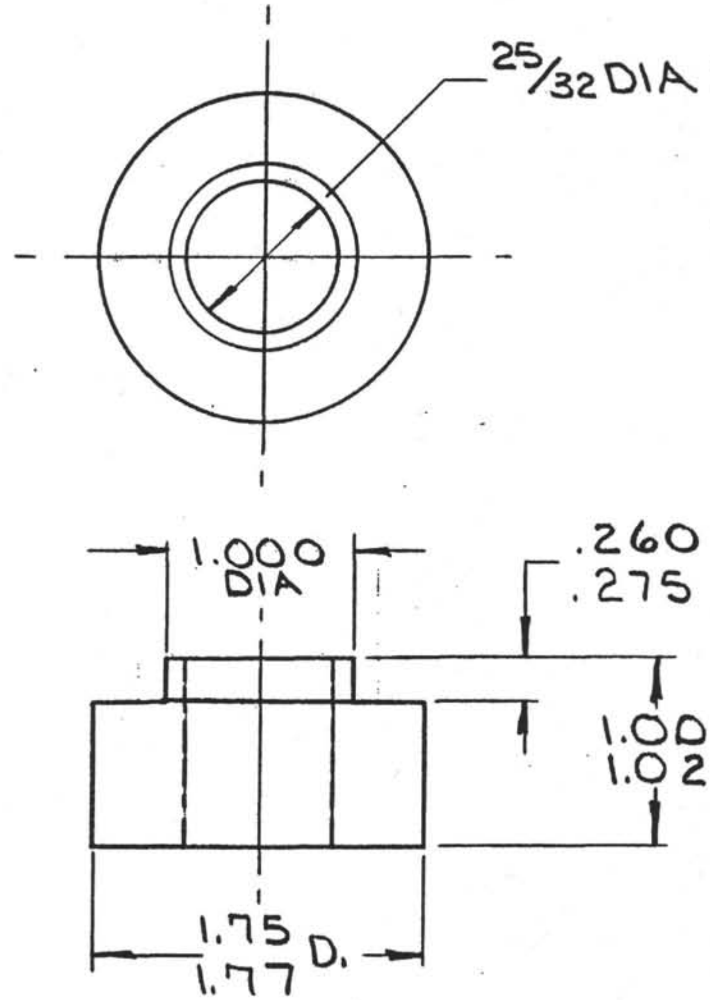

REVISIONS
NO. | DESCRIPTION | DATE | BY | CH. | APR.
1 | ADDED DISCRIPTIVE LABLES | 1-26-84 | RK
14.5'
10'
12'2"
WIRELINE RE-ENTRY ASS'Y (OH1117)
FIN BARREL (OH1129)
3/4 BOLT, NUT, F/W, L/W
ORE BEACON
WIRELINE RE-ENTRY PACKAGE (800 LBS IN AIR 550 LBS IN WATER)
RE-ENTRY CONE
1/4 PL
1/4 PL
3/8 EYEBOLT, 3/8 L/N, TURNBUCKLE, CABLE ASSY (OH1127), SHACKLE
FIN (OH1128) 3 REQ'D
30°
LEAD WEIGHT (6), 1/2 ALL THREAD, 1/2 F/W, 1/2 L/N
RELEASE BAR (OH1131), RELEASE BAR STANDOFF (OH1132), 3/4 BOLT, NUT, F/W, L/W, ELASTIC BANDS.
NO SCALE
24" I.D. CASING (.5 WALL)
DO NOT SCALE
CONCENTRICITY ALL DIAMETERS: TIR .003
TOLERANCES UNLESS NOTED
FRACTIONS ± 1/64
DECIMALS ± .005
ANGLES ± 1/2°
CORNERS 1/64 x 45° or 1/64 R
FINISH 125
DEEP SEA DRILLING PROJECT
SCRIPPS INSTITUTION OF OCEANOGRAPHY
UNIVERSITY OF CALIFORNIA, SAN DIEGO
LA JOLLA, CALIFORNIA 92093
TITLE WIRELINE RE-ENTRY SYSTEM
SURFACE TREATMENT
MATERIAL
DATE Mar 82
BY
CHECKED 3-15-82
APPROVED
HEAT TREATMENT
SCALE 1"=1.5'
REQ'D/ASS'Y
PART NO. OH1133-1
DWG. NO. B-OH1133-1 (REV.)

NO.	DESCRIPTION	DATE	BY	CH.	APR.

REVISIONS



DO NOT SCALE

CONCENTRICITY ALL DIAMETERS: TIR .003

TOLERANCES UNLESS NOTED FRACTIONS ± 1/64 DECIMALS ± .005 ANGLES ± 1/2° CORNERS 1/64 x 45° or 1/64 R FINISH 125	DEEP SEA DRILLING PROJECT SCRIPPS INSTITUTION OF OCEANOGRAPHY UNIVERSITY OF CALIFORNIA, SAN DIEGO LA JOLLA, CALIFORNIA 92093 TITLE RELEASE BAR STANDOFF WIRELINE RE-ENTRY				
SURFACE TREATMENT —	MATERIAL 6061 ALUM.	DATE 3.30.82	BY RK	CHECKED DB 4-8-82	APPROVED
HEAT TREATMENT —	SCALE 1:1	REQ'D/ASS'Y 3	PART NO. OH1132	DWG. NO. A-OH1132	(REV.)

DRAWING LIST (ELECTRICAL) FOR WIRELINE RE-ENTRY SYSTEM*

X11586	Installation Drawing for Transceiver Assembly
39071	Electronics Assy, Wiring Diagram
38874	Motor Control, Electrical Schematic
30496	Motor Assy
19530	Feedthru, High-Pressure
19763	Model 516 Transceiver Electronics Function Schematic (Old)
39068	Model 516 Transceiver Electronics Function Schematic (New)
38957	Compass Housing
38958	Universal Joint
38987	Potentiometer
38959	Mounting bracket
19400	System Drawing, Cabling & Signal Flow System 4014
19544	Housing
19477	Housing, Motor Cylinder
20163	Motor Drive Assembly, Wiring Diagram
27030	Weldment, Electronics Chassis
24858	Electronics Assembly
20084	Motor Drive (Printed Circuit Board Assembly)
30688	Motor Drive Assy
38873	Motor Control, Printed Circuit Board Detail
38872	Motor Control (P.C. Assembly)
PL30688	Motor Drive Assy
PL24858	Electronics Assembly
PL20084	Motor Drive (Printed Circuit Board Assembly)
PL19400	System Drawing, Cabling & Signal Flow System 4014
PL38872	Motor Control (P.C. Assembly)
PL19362	Transceiver Assembly
EC07647	
EC07648	
EC07649	
EC07721	Engineering Change Orders
EC07722	
EC07724	
EC07725	

*Numbers are EDO Western drawing numbers. Also, see EDO Western Manual for 5/6 Sonar Tool.

APPENDIX A

WIRELINE TOW AND RE-ENTRY
INTO AN
EXISTING DEEP WATER DRILL HOLE

W. Nugent & Associates Engineers
3736 Gayle Street
San Diego, California 92115

PROBLEM STATEMENT

Investigate the behavior of an instrument package deployed as a depressor on a cable in water depth from 5000 ft to 20,000 feet with ocean currents varying from 3 knots at the surface to zero at 20,000 feet depth. Provide also for ship speed conditions up to 0.5 knot.

Design Constraints

- Cable weight = 0.282 LB/Lineal Foot
- Cable diameter = 0.46875 Inches
- Cable allowable load = 11,000 Lbs tension
- Instrument Weight = 600 to 1000 LBS

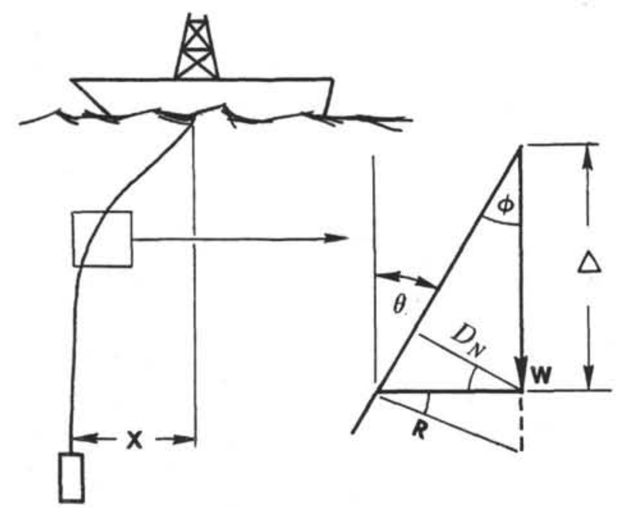
OBJECTIVE

Determine the displacement x between the surface vessel and the depressor (instrument package) at the submerged depth. Predict the broaching angle of the cable at the surface and the shape of the descending cable. Determine the cable tension at intervals of depth under the influence of cable weight, depressor weight and the force produced by current drag.

APPROACH TO THE SOLUTION

An investigation of current data on submerged and towed depressors was used as a guideline in the wireline project. Depth of the depressor and varying current appeared to exceed the limits of accuracy by interpolation of existing tables. The Navy Civil Engineering Laboratory paper L.44/SSS dated October 6, 1980 provides a reasonable insight to the problem. The work by Leonard Pode was invaluable in setting up the equation for equilibrium and developing the step integration program.

General Form For Determination



INSTRUMENT

SYMBOLS

Δ	=	INCREMENTAL DEPTH (FT)
R	=	CABLE DRAG NORMAL TO CURRENT
D_N	=	DRAG COMPONENT NORMAL TO CABLE
W	=	VERTICAL COMPONENT OF TOTAL WEIGHT ON Δ ELEMENT

EQUATION OF EQUILIBRIUM

$$W \sin\theta = R \cos^2\theta \quad \textit{such that} \quad \frac{W\sin\theta}{R\cos^2\theta} = 1$$

$$\textit{THEN} \quad \frac{W}{R}\sin\theta = 1 - \sin^2\phi$$

$$\sin^2\theta + \frac{W}{R}\sin\theta = 1 \quad \textit{NOW COMPLETE THE SQUARE}$$

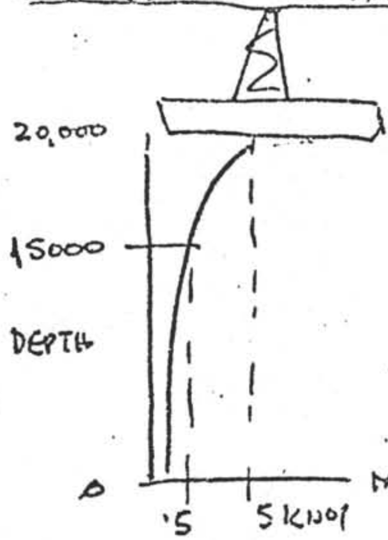
$$\sin^2\theta + \frac{W}{R}\sin\theta + \left(\frac{W}{2R}\right)^2 = 1 + \left(\frac{W}{2R}\right)^2$$

$$\sin\theta = \sqrt{1 + \left(\frac{W}{2R}\right)^2} - \frac{W}{2R}$$

L.W. Nugent & Associates Engineers
3736 Gayle Street
San Diego, California

WIRELINE

EQUATION FOR VARIABLE CURRENT



	A	B
DEPTH	15000	20000
VELOCITY	.5 KT	5 KT

THEN FOR ASSYMPTOTIC DECAY IN CURRENT VELOCITY

$$.5L - 15000(.5) = 5L - 20000(5)$$

$$\therefore \quad L = \frac{92500}{4.5} = 20{,}555.555$$

$$V_o = 5 - \left[\frac{5 \times 20{,}000}{20{,}555}\right] = 5 - 4.8648. = .135135$$

WE CAN USE AN EXPRESSION $V = V_o\left[\frac{L}{L-X}\right]$

WHERE V = DESIRED CURRENT VELOCITY AT A GIVEN DEPTH X

V_o = MINIMUM VELOCITY AT MAXIMUM DEPTH

L = CHARACTERISTIC DEPTH

X = DEPTH OF DEPRESSOR MINUS DEPTH OF INTEREST, e.g., (20,000 - 5 000)

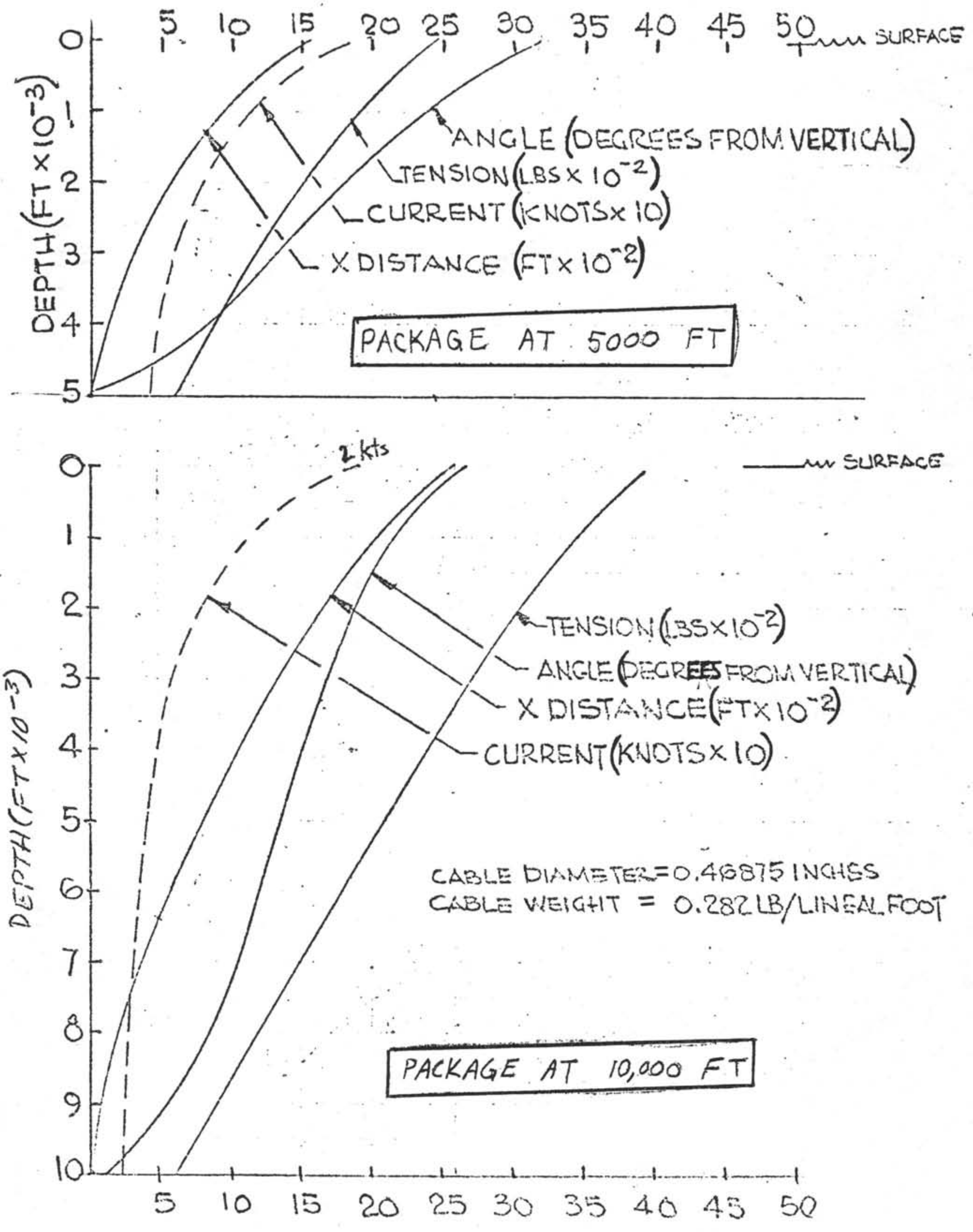
EXAMPLE: REQUIRE THE ESTIMATE OF THE VELOCITY AT 12, 500 FT.

$$V = .135\left[\frac{20{,}555}{20.555-(20{,}000-12{,}500)}\right]$$

$= .212$ KNOTS

INTEGRATE THE Δ DEPTH OVER THE DEPTH OF THE DEPRESSOR USING THE VALUES FOR THE CURRENT VELOCITY PROFILE TO DEVELOP VALUES FOR DRAG (R) NORMAL TO THE STREAM. THEN RESOLVE THE INCREMENTAL WEIGHT AND DRAG IN THE EQUILIBRIUM EQUATION USING $\sin\theta = \sqrt{\left(\frac{W}{2R}\right)^2+1} - \frac{W}{2R}$ TO PREDICT THE CABLE ANGLE TO THE VERTICAL. A SET OF CONDITIONS IS DETERMINED AT EACH Δ DEPTH. THESE DATA ARE COMPILED INTO A T 59 PROGRAM WHICH SOLVES FOR CURRENT VELOCITY, CABLE ANGLE TO THE VERTICAL, X DISPLACEMENT FROM THE SURFACE VESSEL, CABLE TENSION, AND LENGTH OF THE DEPLOYED CABLE.

TOWED CABLE WITH 600LB DEPRESSOR
0.5 KNOT SHIP SPEED



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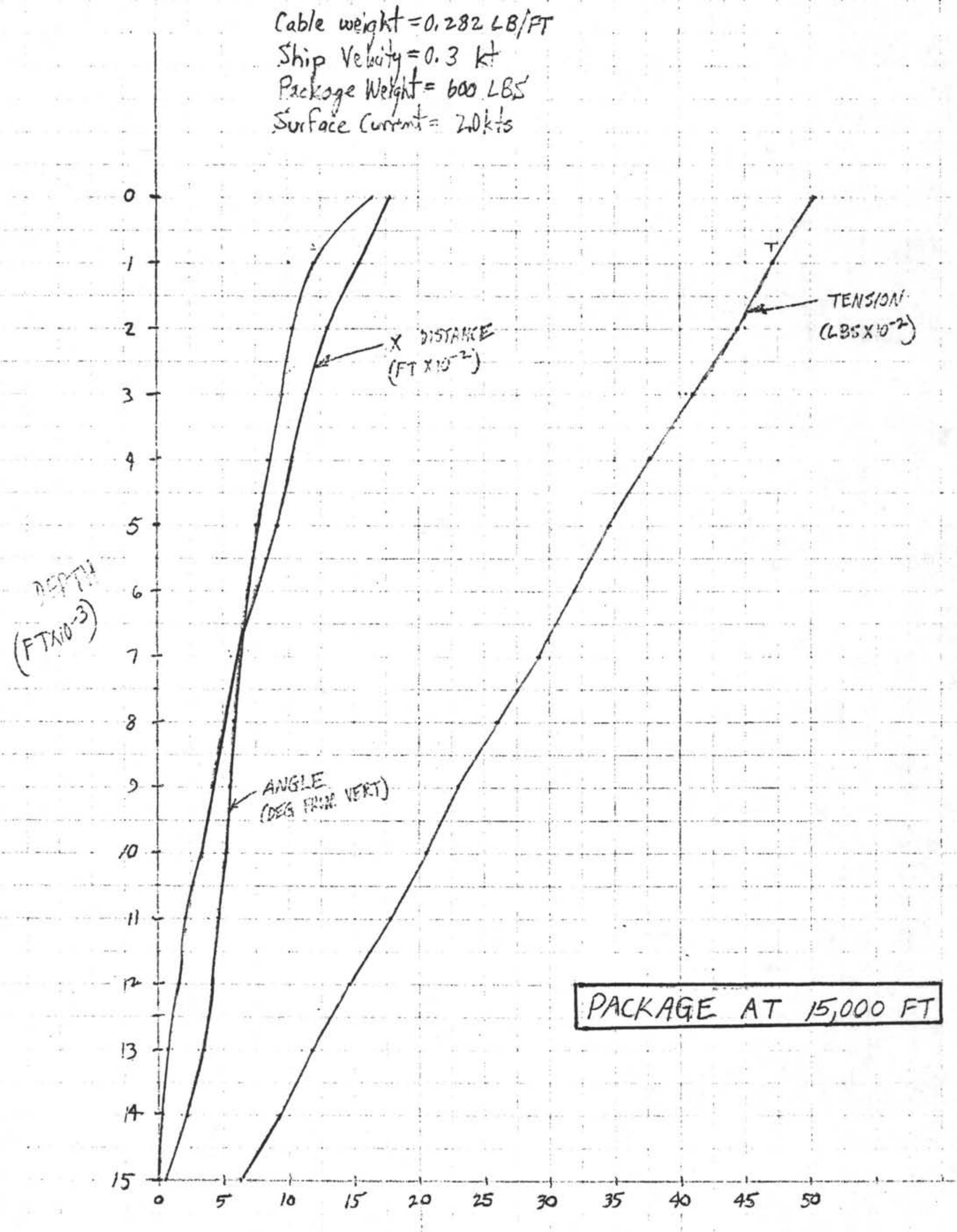
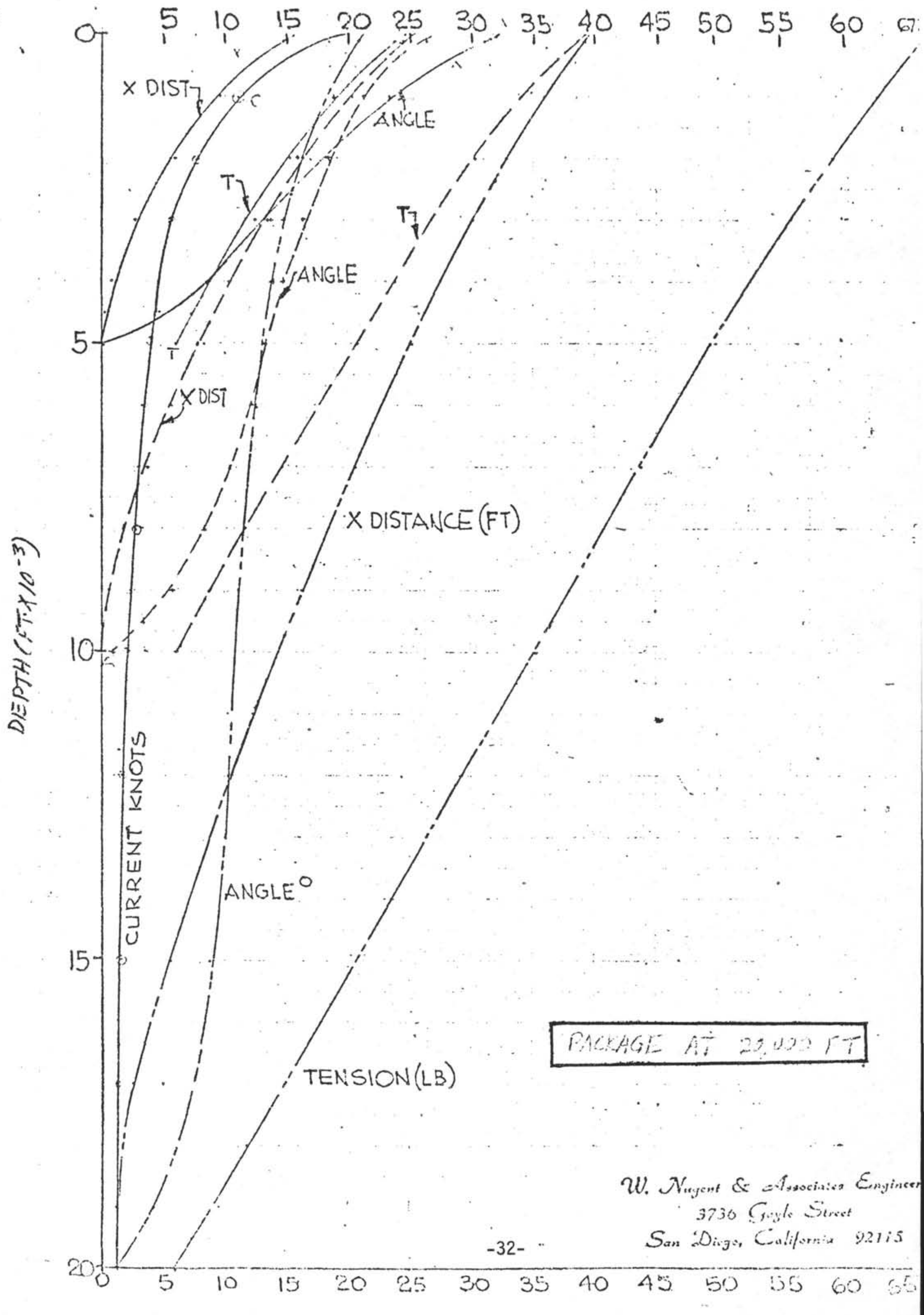

Cable weight = 0.282 LB/FT
Ship Velocity = 0.3 kt
Package Weight = 600 LBS
Surface Current = 2.0 kts
DEPTH (FT x 10^-3)
X DISTANCE (FT x 10^-2)
TENSION (LBS x 10^-2)
ANGLE (DEG FROM VERT)
PACKAGE AT 15,000 FT



W. Nugent & Associates Engineers
3736 Goyle Street
San Diego, California 92115

APPENDIX B

ACOUSTIC CALIBRATION

OF

WIRELINE RE-ENTRY SONAR

EDO CORPORATION WESTERN DIVISION

ACOUSTIC CALIBRATION FACILITY NO. II

Figure 1

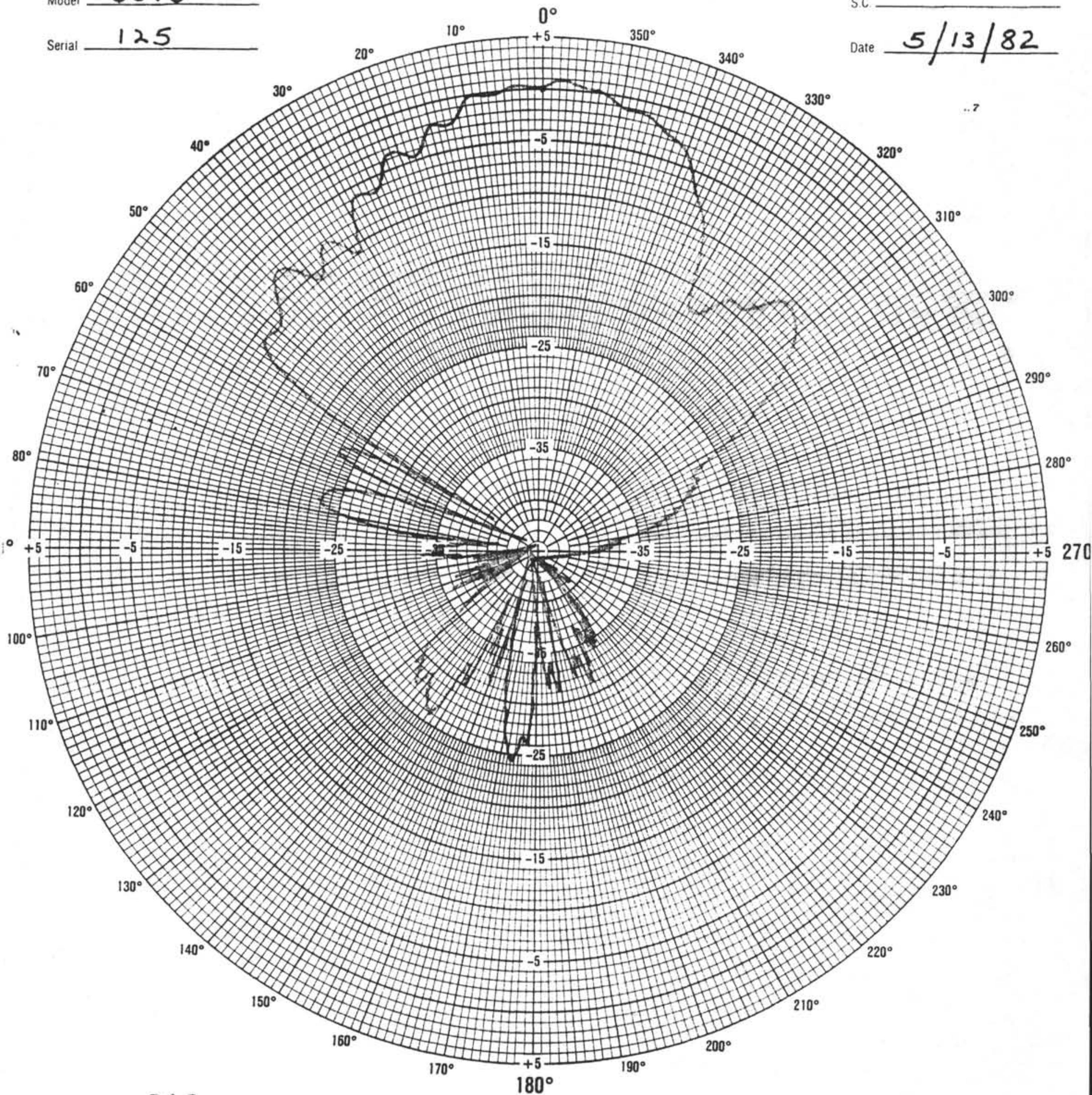
Model 6046

Serial 125

Report ______

S.C. ______

Date 5/13/82



Frequency 310 kHz

Trans. X Rec. ______

Hor. X Vert. ______ Directivity Pattern

Test Depth 3.0 m

Test Distance 3.0 m

TR/V 159.7 dB re 1 μPa/ volt at 1 m

TR/W 184.4 dB re 1 μPa/watt at 1 m

Z 166.6 ∠-56.0°

RR -199.6 dB re 1 volt/μPa

Ref. Standard Model NRL E27

Water Temperature 13.7 °C

Remarks w/o cage search element

EDO 2033B

EDO CORPORATION WESTERN DIVISION

ACOUSTIC CALIBRATION FACILITY NO. II

Figure 3

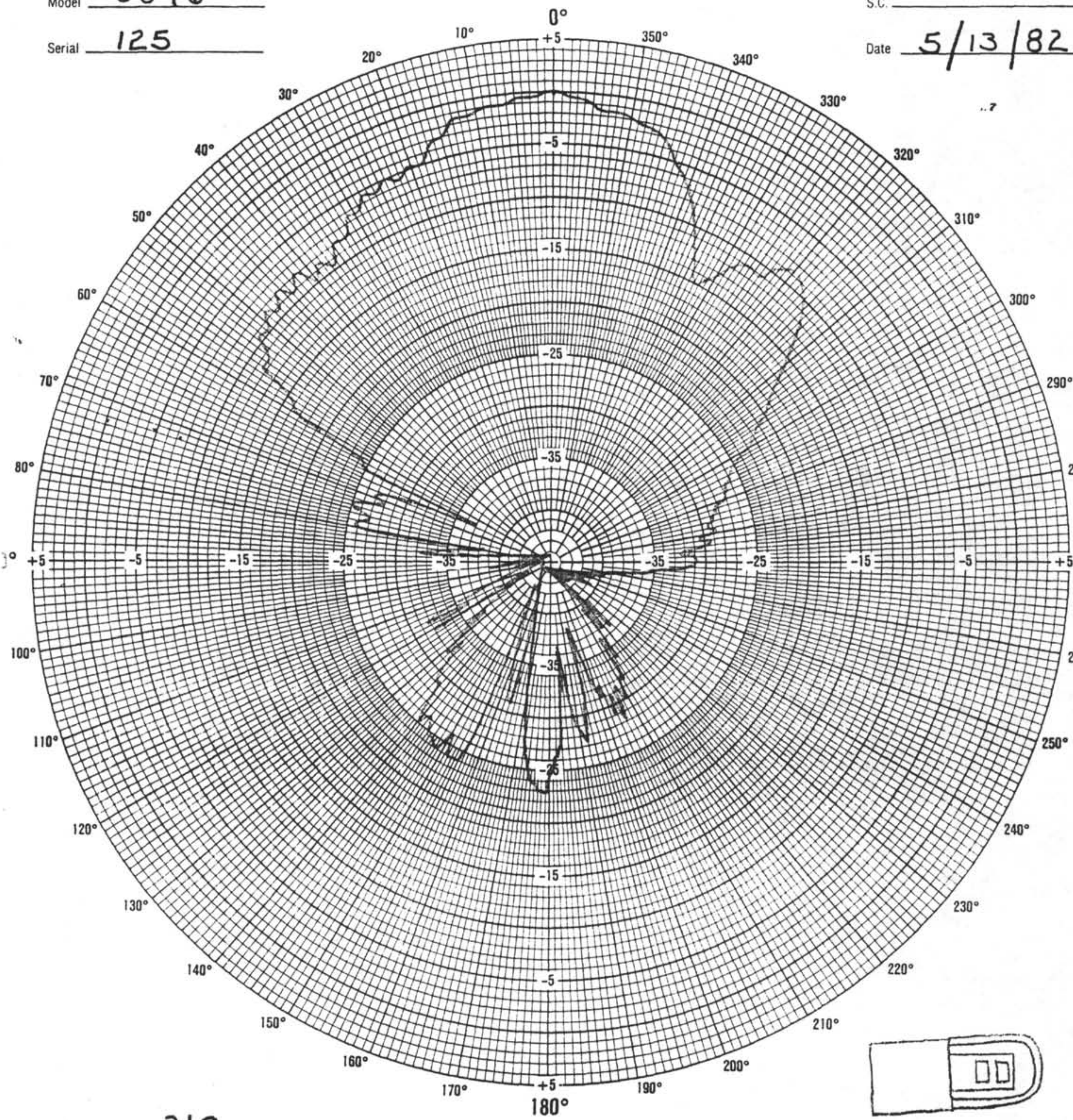
Model 6046

Serial 125

Report

S.C.

Date 5/13/82



Frequency 310 kHz

Trans. X Rec.

Hor. X Vert. Directivity Pattern

Test Depth 3.0 m

Test Distance 3.0 m

TR/V dB re 1 μPa/ volt at 1 m

TR/W dB re 1 μPa/watt at 1 m

Z

RR dB re 1 volt/μPa

Ref. Standard Model NRL E27

Water Temperature 13.7 °C

Remarks With cage - between bars

EDO 2033B

Search element

EDO CORPORATION WESTERN DIVISION

ACOUSTIC CALIBRATION FACILITY NO. II

Figure 6

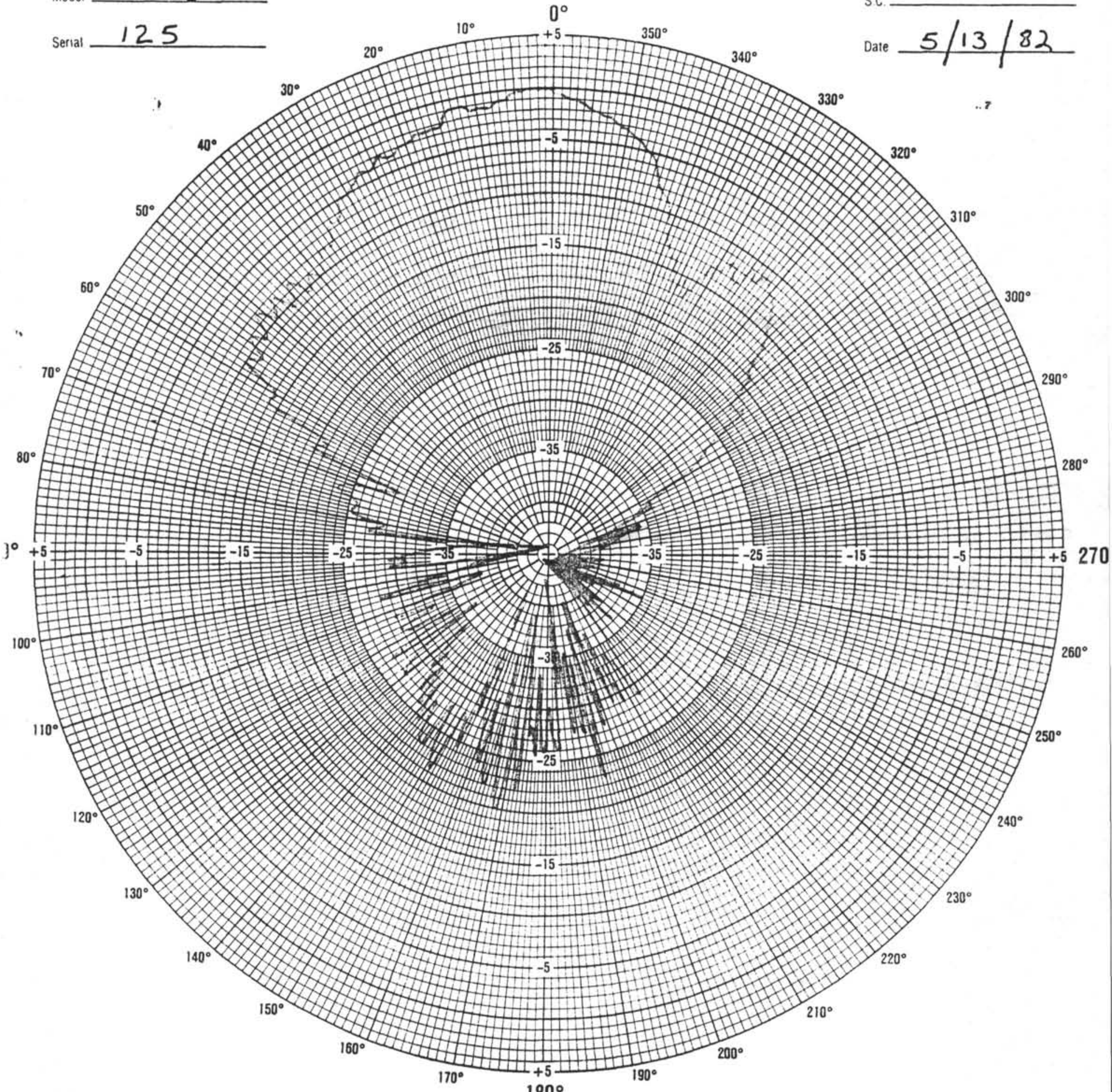
Model 6046

Serial 125

Report

S.C.

Date 5/13/82



Frequency 310 kHz

Trans. X Rec.

Hor. X Vert. Directivity Pattern

Test Depth 3.0 m

Test Distance 3.0 m

TR/V dB re 1 μPa/ volt at 1 m

TR/W dB re 1 μPa/watt at 1 m

Z

RR dB re 1 volt/μPa

Ref. Standard Model NRL E27

Water Temperature 13.8 °C

Remarks with cage - bar across xducer

EDO 2033B

SEARCH element

EDO CORPORATION WESTERN DIVISION

ACOUSTIC CALIBRATION FACILITY NO. II

Figure 2

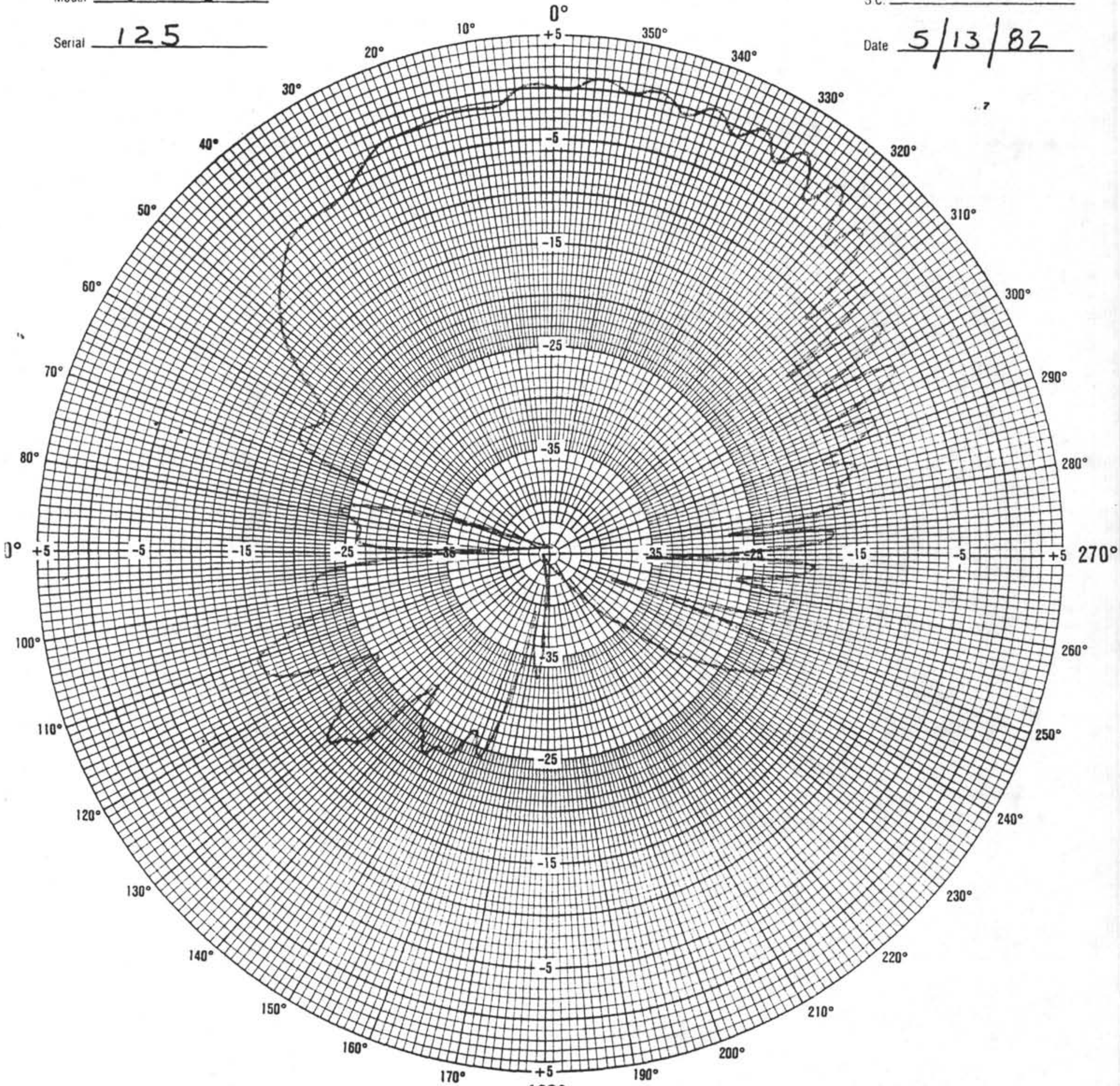
Model 6046

Serial 125

Report

S.C.

Date 5/13/82



Frequency 310 kHz

Trans. x Rec.

Hor. x Vert. Directivity Pattern

Test Depth 3.0 m

Test Distance 3.0 m

TR/V 155.2 dB re 1 μPa/ volt at 1 m

TR/W 182.7 dB re 1 μPa/watt at 1 m

Z 185.1 ∠-70.9

RR -203.2 dB re 1 volt/μPa

Ref. Standard Model NRL E27

Water Temperature 13.7 °C

Remarks w/o cage re-entry element

EDO 2033B

EDO CORPORATION WESTERN DIVISION

ACOUSTIC CALIBRATION FACILITY NO. II

Figure 4

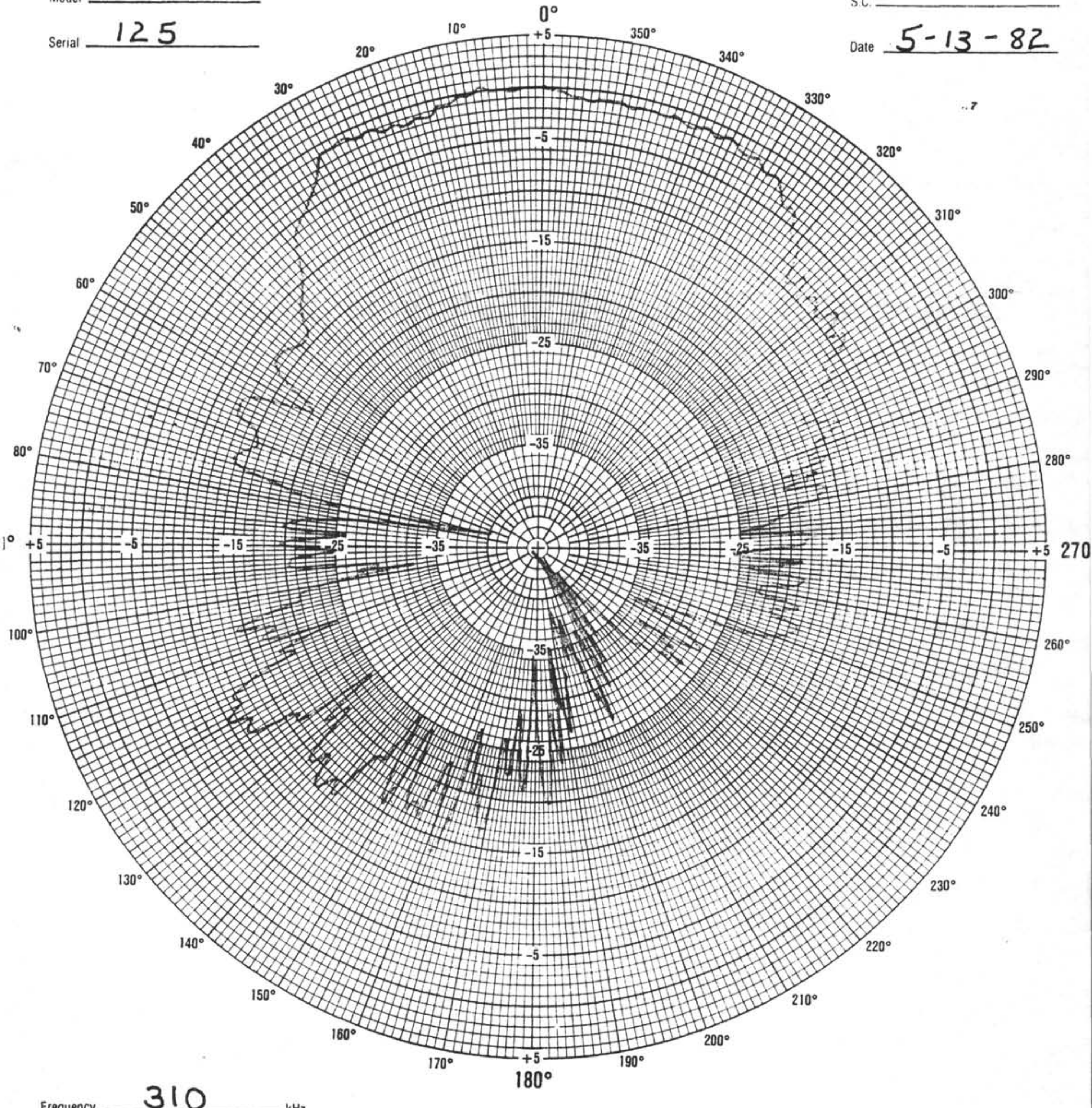
Model 6046

Serial 125

Report

S.C.

Date 5-13-82



Frequency 310 kHz

Trans. X Rec.

Hor. X Vert. Directivity Pattern

Test Depth 3.0 m

Test Distance 3.0 m

TR/V dB re 1 μPa/ volt at 1 m

TR/W dB re 1 μPa/watt at 1 m

Z

RR dB re 1 volt/μPa

Ref. Standard Model NRL E27

Water Temperature 13.7 °C

Remarks with cage - between bars re-entry element

EDO 2033B

EDO CORPORATION WESTERN DIVISION

ACOUSTIC CALIBRATION FACILITY NO. II

Figure 5

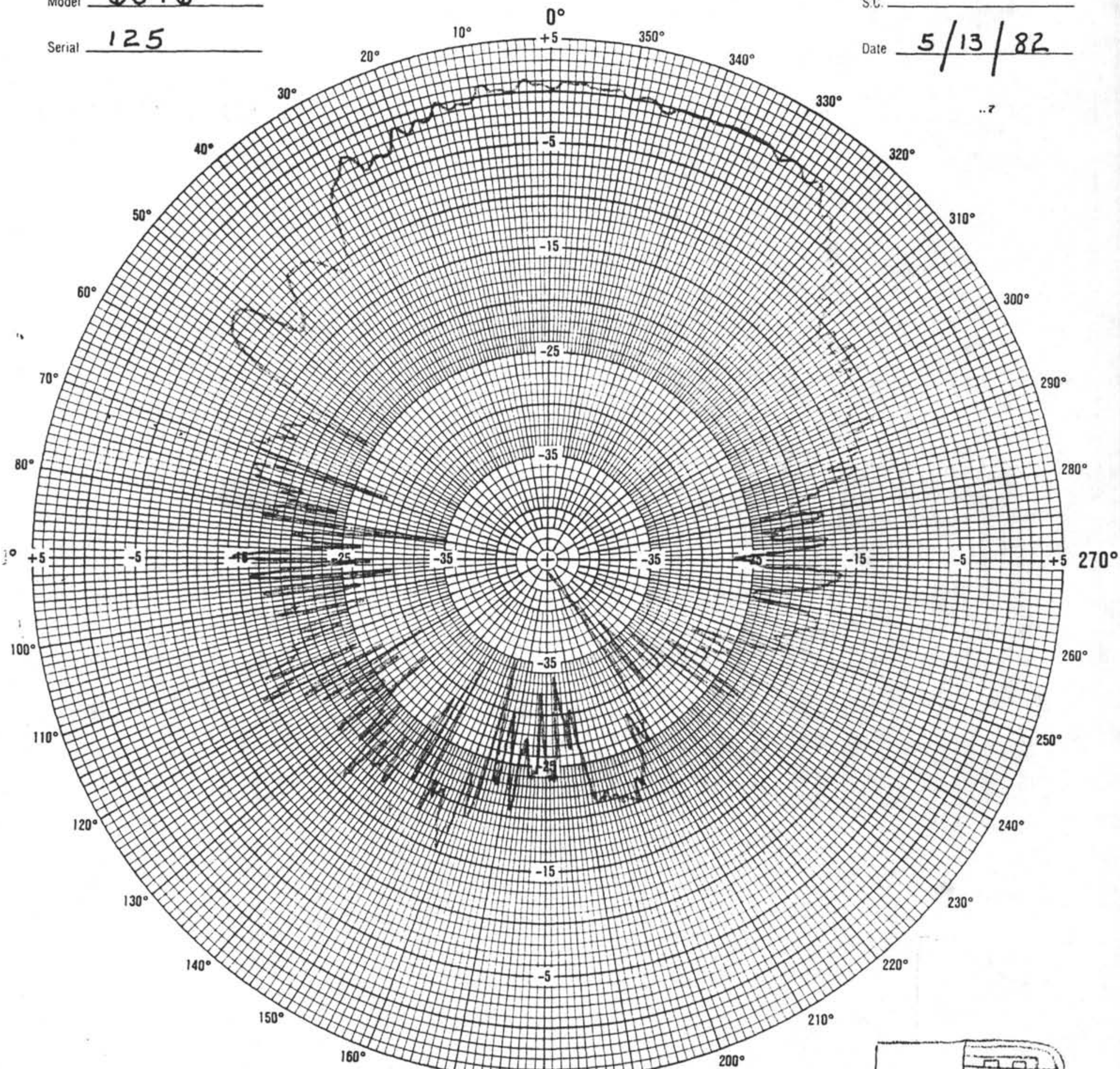
Model 6046

Serial 125

Report ______

S.C. ______

Date 5/13/82



Frequency 310 kHz

Trans. X Rec. ______

Hor. X Vert. ______ Directivity Pattern

Test Depth 3.0 m

Test Distance 3.0 m

TR/V ______ dB re 1 μPa/ volt at 1 m

TR/W ______ dB re 1 μPa/watt at 1 m

Z ______

RR ______ dB re 1 volt/μPa

Ref. Standard Model NRL E27

Water Temperature 13.8 °C

Remarks with cage-bar across xducer re-entry element

EDO 2033B

Edo Western CORP

ACOUSTIC CALIBRATION FACILITY NO. II

Figure ________

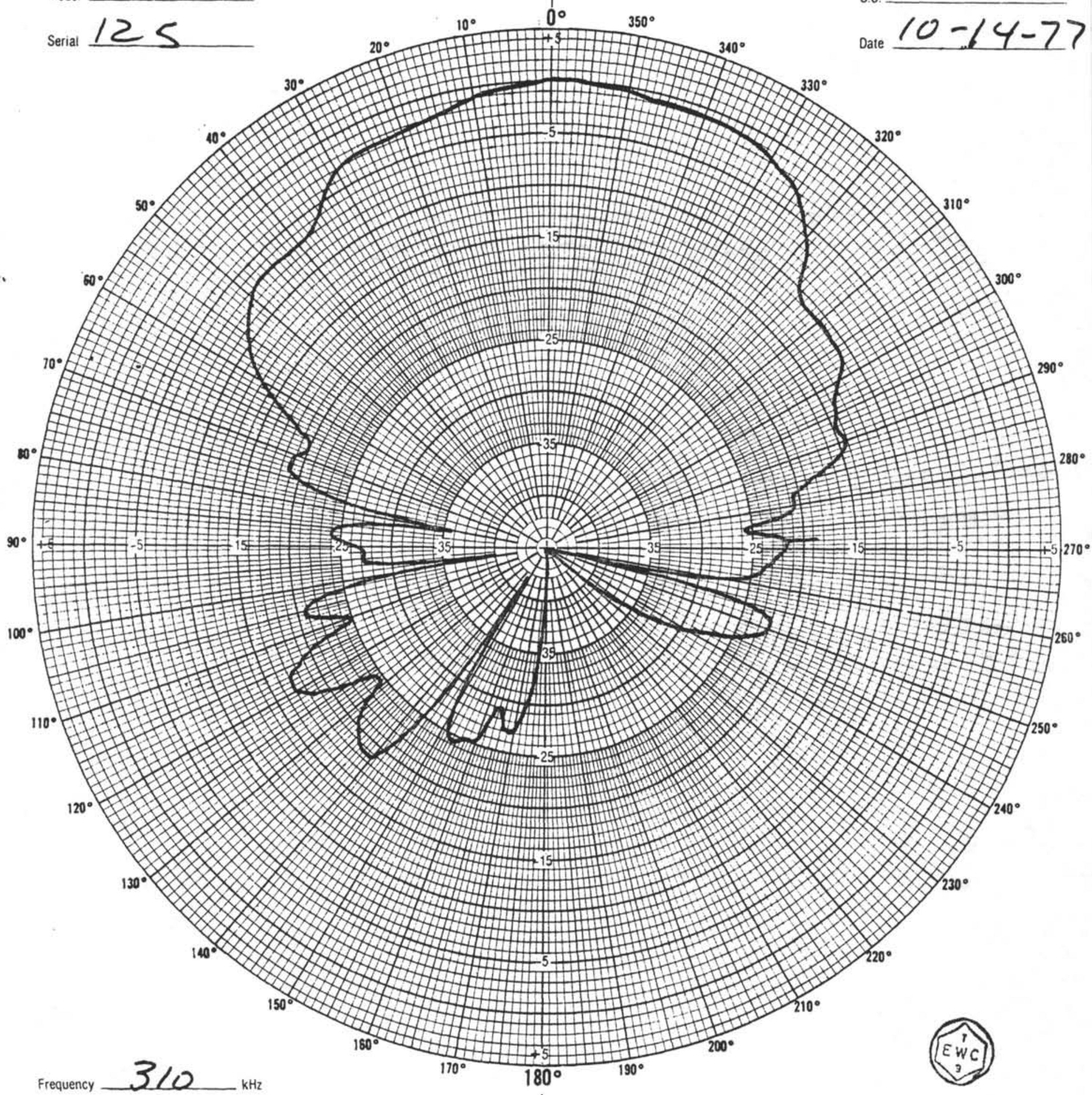
Model 6046

Serial 125

Report ________

S.C. ________

Date 10-14-77



EWC

Frequency 310 kHz

Trans. X Rec. ________

Hor. X Vert. ________ Directivity Pattern

Test Depth 9 ft.

Test Distance 40 ft.

TR/V = 54.3dB

RR = -91.6dB

Z = 862∠+4.6°

TR/W = 83.6dB

Ref. Standard Model NRL E-27

Water Temperature 57 F°

Remarks reentry APT

EDO 2033

ACOUSTIC CALIBRATION FACILITY NO. II

Figure ______

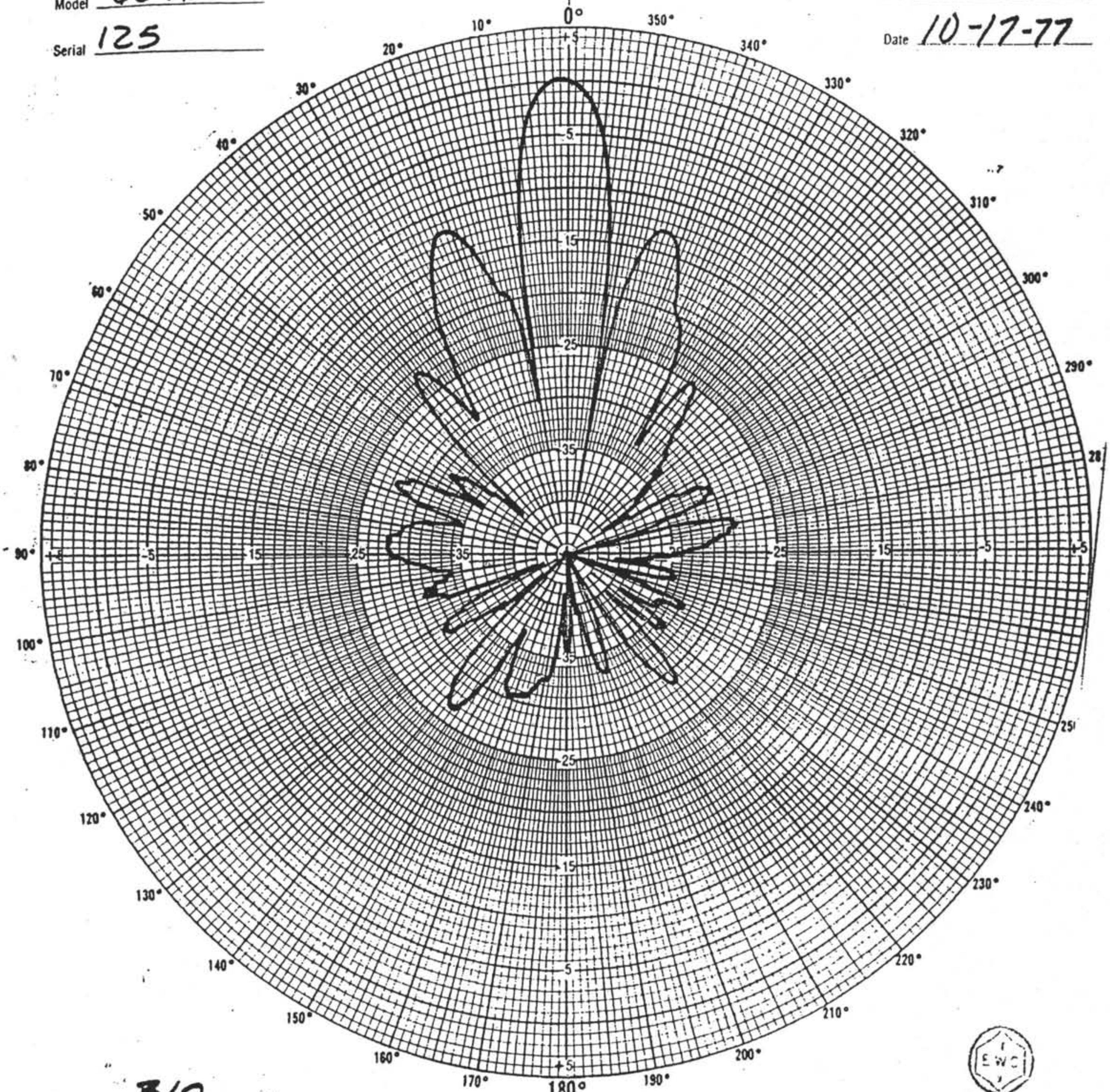
Model 6046

Serial 125

Report ______

S.C. ______

Date 10-17-77



Frequency 3/0 kHz

Trans. X Rec. ______

Hor. ______ Vert. X Directivity Pattern

Test Depth 9 ft.

Test Distance 40 ft.

TR/V = 54.3dB

RR = -91.6dB

Z = 862∠+4.6°

TR/W = 83.6dB

Ref. Standard Model NRL

Water Temperature 57

Remarks reentry

APT

Edo Western CORP

ACOUSTIC CALIBRATION FACILITY NO. II

Figure ______

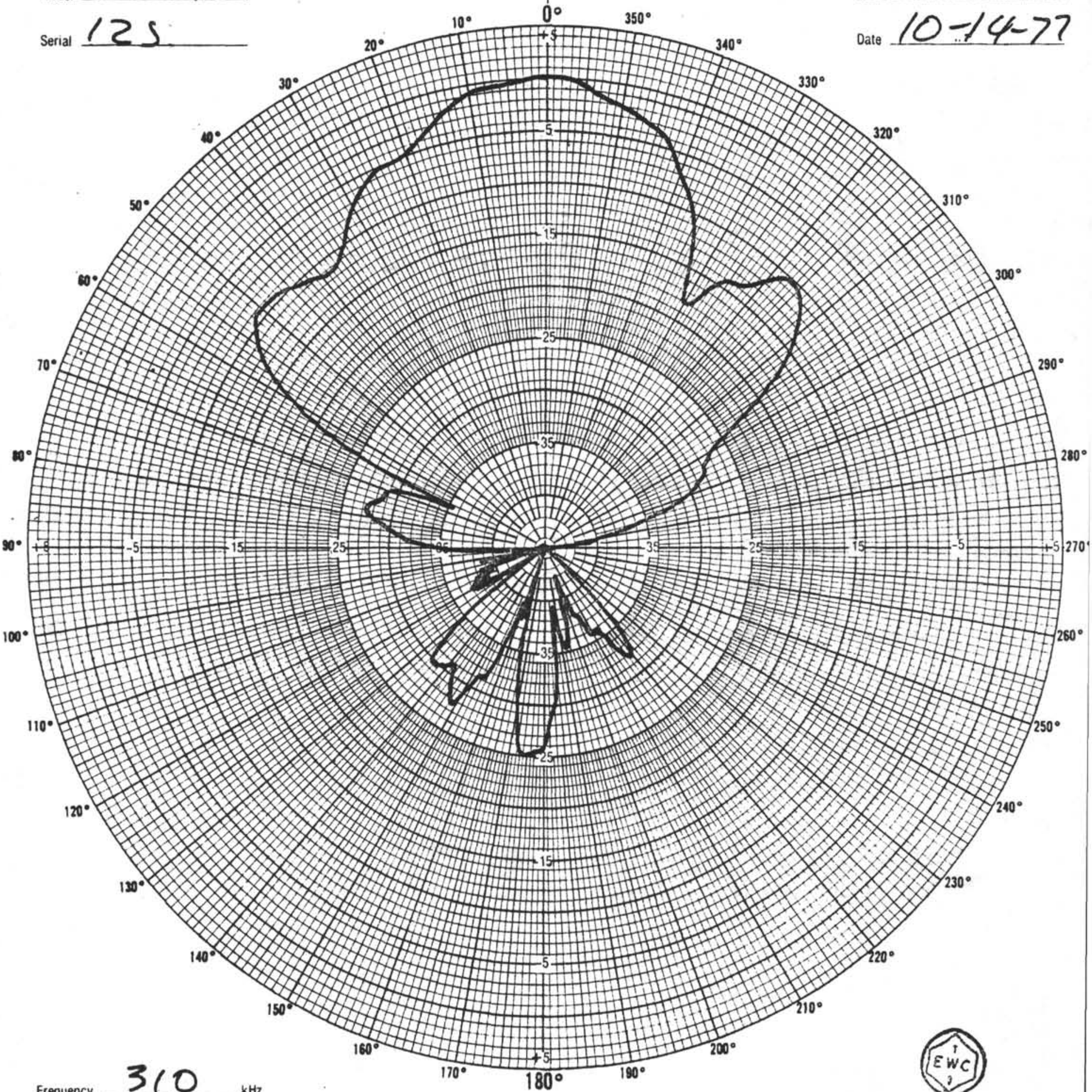
Model 6046

Serial 125

Report ______

S.C. ______

Date 10-14-77



Frequency 310 kHz

Trans. X Rec. ______

Hor. X Vert. ______ Directivity Pattern

Test Depth 9 ft.

Test Distance 40 ft.

TR/V = 59.3 dB
RR = -93.6 dB
Z = 384∠+9.2°
TR/W = 85.2 dB

Ref. Standard Model NRL E-27

Water Temperature 57 F°

Remarks search APT

EWC

EDO 2033

Edo Western CORP.

ACOUSTIC CALIBRATION FACILITY NO. II

Figure ______

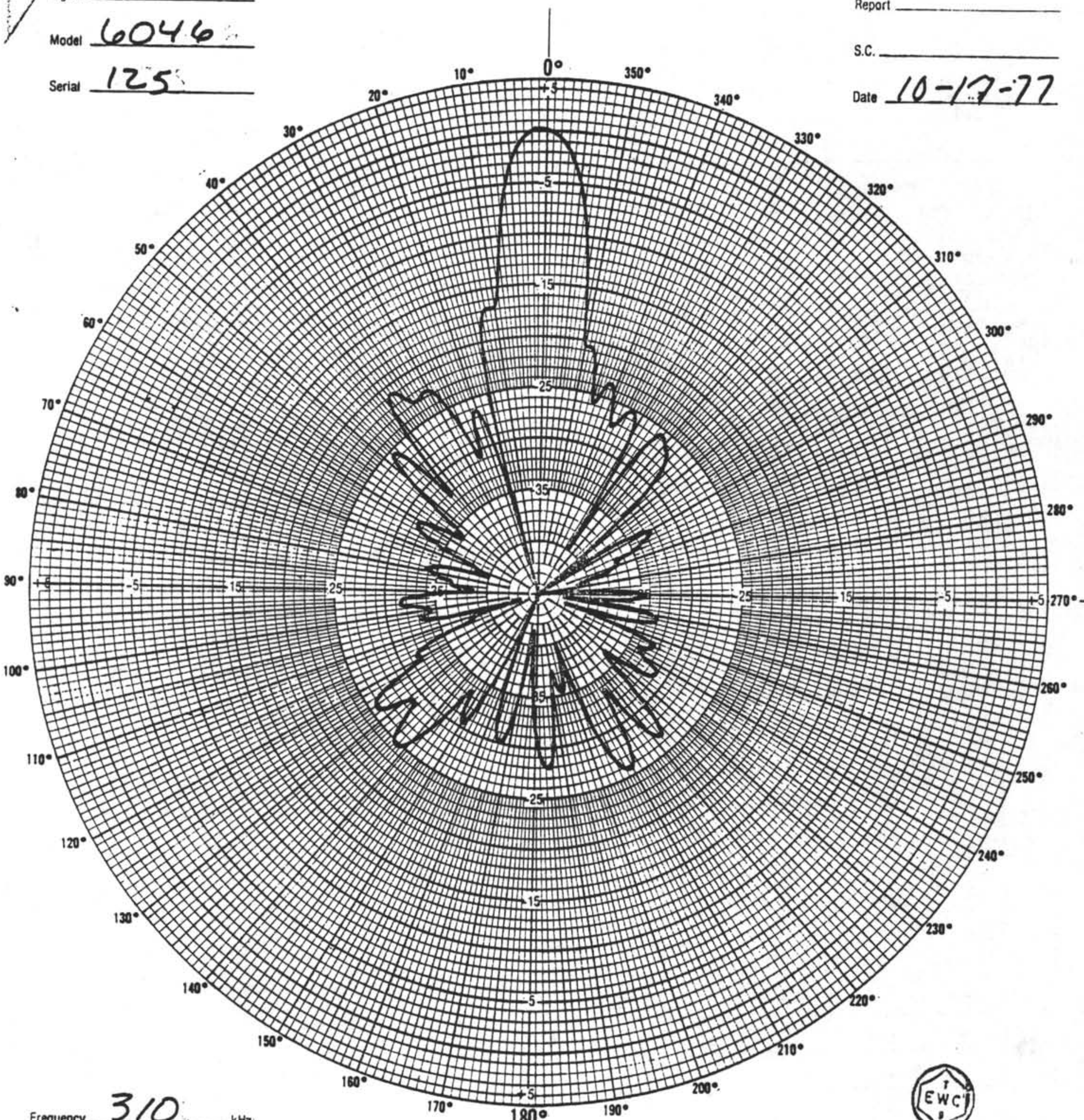
Model 6046

Serial 125

Report ______

S.C. ______

Date 10-17-77



Frequency 310 kHz

Trans. X Rec. ______

Hor. ______ Vert. X Directivity Pattern

Test Depth 9 ft.

Test Distance 40 ft.

TR/V = 59.3dB

RR = -93.6dB

Z = 384 ∠+9.2°

TR/W = 85.2dB

Ref. Standard Model NRL E-27

Water Temperature 57 F°

Remarks search APT

EWC

EDO 2033

re-entry element
between bars

Edo Western CORP.
Salt Lake City, Utah 84115
EDO 2028

TRANSDUCER CALIBRATION REPORT

TEST FACILITY NO.______

MODEL ______ TYPE ______ STANDARDS ______

SC ______ DEPTH ______ TESTED BY ______

SN ______ WATER TEMP ______ DATE ______

Test Cond.						
Freq.		310 Khz				
RRs TR/Vs		-224.2				
Vd	3m	9.5				
Vrec		.007Vpp				
Gain		0				
Vin		100 Vpp				
TR/V		150.6 dB				
RR	cal.					
	meas.					
Ls						
Z						
Rp						
TR/W						
Pin						
Eff						
Cable	lgth					
	type					
	Z					
	Rp					
	loss					

INSULATION RESISTANCE

TUNING DATA

Lead/Lead		Network		Gain	
Lead/Water		Zreq/freq		Turns/Ratio	
Shield/Water		Zdcr		Core No.	
REMARKS		Lpri		Mh/1000t	
		Lsec		Tpri	
		Max Power		Tsec	

bar across xducer face

Edo Western CORP.
Salt Lake City, Utah 84115
EDO 2028

TRANSDUCER CALIBRATION REPORT

TEST FACILITY NO. II

MODEL 6046 TYPE ______ STANDARDS NRL E27

SC 53-1523-71 DEPTH 3m TESTED BY [illegible]

SN 125 WATER TEMP 13.7°C DATE 5-13-82

Test Cond.		Search	Re-entry			
Freq.		310 Khz	310 Khz			
RRs TR/Vs		-224.2	-224.2			
Vd	3m	9.5dB	9.5dB			
Vrec		.014	.0065 Vpp			
Gain		0	0			
Vin		100 Vpp	100Vpp			
TR/V		156.6 dB	149.9 dB			
RR	cal.	-202.7dB	-208.2 dB			
	meas.					
Ls						
Z		166.6 ∠-54.7	192.3 ∠-69.5			
Rp		288.8	549.1Ω			
TR/W		181.2 dB	177.2 dB			
Pin						
Eff						
Cable	lgth					
	type					
	Z					
	Rp					
	loss					

INSULATION RESISTANCE — TUNING DATA

Lead/Lead		Network		Gain	
Lead/Water		Zreq/freq		Turns/Ratio	
Shield/Water		Zdcr		Core No.	
REMARKS		Lpri		Mh/1000t	
		Lsec		Tpri	
		Max Power		Tsec	

Edo Western CORP.
Salt Lake City, Utah 84115
EDO 2028

TRANSDUCER CALIBRATION REPORT
TEST FACILITY NO. II

MODEL 6046 TYPE ______ STANDARDS NRL E27
SC ______ DEPTH 3m TESTED BY [illegible]
SN 125 WATER TEMP 13.8°C DATE 5-13-82

Test Cond.		search	re-entry			
Freq.		310 Khz	310 Khz			
RRs TR/Vs		-224.2 dB	-224.2 dB			
Vd	3m	9.5 dB	9.5 dB			
Vrec		.02 Vpp	.012 Vpp			
Gain		0	0			
Vin		100 Vpp	100 Vpp			
TR/V		159.7	155.2 dB			
RR	cal.	-199.6	-203.2			
	meas.					
Ls						
Z		166.6 |-56.0	185.1 |-70.9			
Rp		298.4 Ω	565.7 Ω			
TR/W		184.4 dB	182.7 dB	μPa		
Pin						
Eff						
Cable	lgth					
	type					
	Z					
	Rp					
	loss					

INSULATION RESISTANCE

TUNING DATA

Lead/Lead		Network		Gain	
Lead/Water		Zreq/freq		Turns/Ratio	
Shield/Water		Zdcr		Core No.	
REMARKS		Lpri		Mh/1000t	
		Lsec		Tpri	
		Max Power		Tsec	

Edo Western Corp.
Salt Lake City, Utah 84115
EDO 2028

TRANSDUCER CALIBRATION REPORT

TEST FACILITY NO. II

MODEL 6046 TYPE ______ STANDARDS NRL E-27
SC ______ DEPTH 9 TESTED BY RP
SN 125 WATER TEMP 57 DATE 10-14-77

Test Cond.		yellow	ylcentry			
Freq.		310 K				
RRs TR/Vs		125.5 dB				
Vd		223 dB				
Vrec		4.2 mV	3.4 mV			
Gain		0 dB				
Vin		115 V	165 V			
TR/V		59.3 dB	54.3 dB			
RR	cal.	-94.3 dB	-93.0 dB	-93.6 dB	-91.6 dB	
	meas.					
Ls						
Z		357 ∠+14°	735 ∠+9°	384 ∠+9.2°	862 ∠+4.6°	
Rp		367Ω	744Ω	389Ω	864Ω	
TR/W		85.0 dB	83.0 dB	85.2 dB	83.6 dB	μbar
Pin		Search				
Eff						
Cable	lgth					
	type					
	Z					
	Rp					
	loss					

INSULATION RESISTANCE / TUNING DATA

Lead/Lead		Network		Gain	
Lead/Water		Zreq/freq		Turns/Ratio	
Shield/Water		Zdcr		Core No.	
REMARKS		Lpri		Mh/1000t	
		Lsec		Tpri	
		Max Power		Tsec	

APPENDIX C

DRILL PIPE TRACKS DURING RE-ENTRY

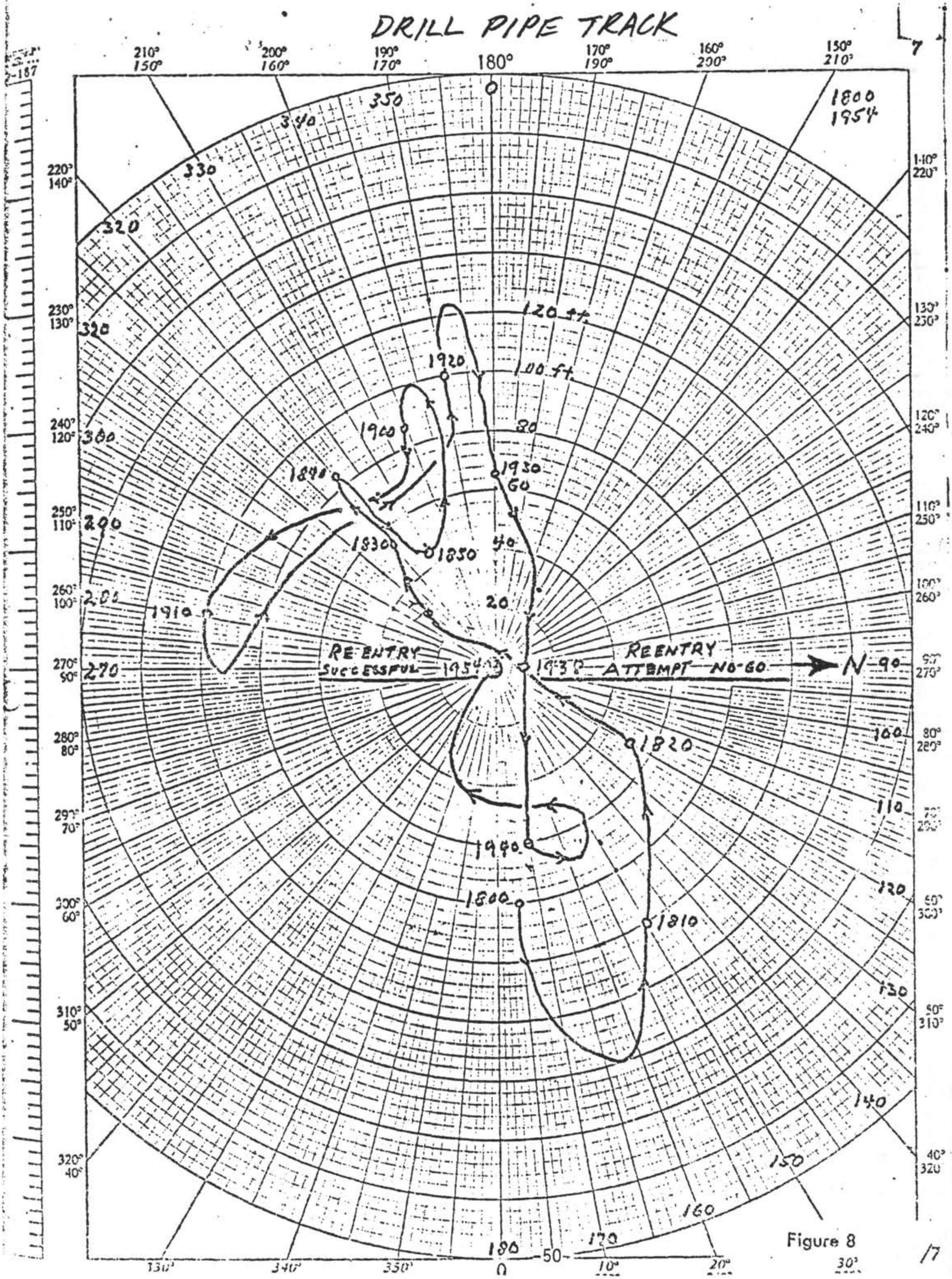
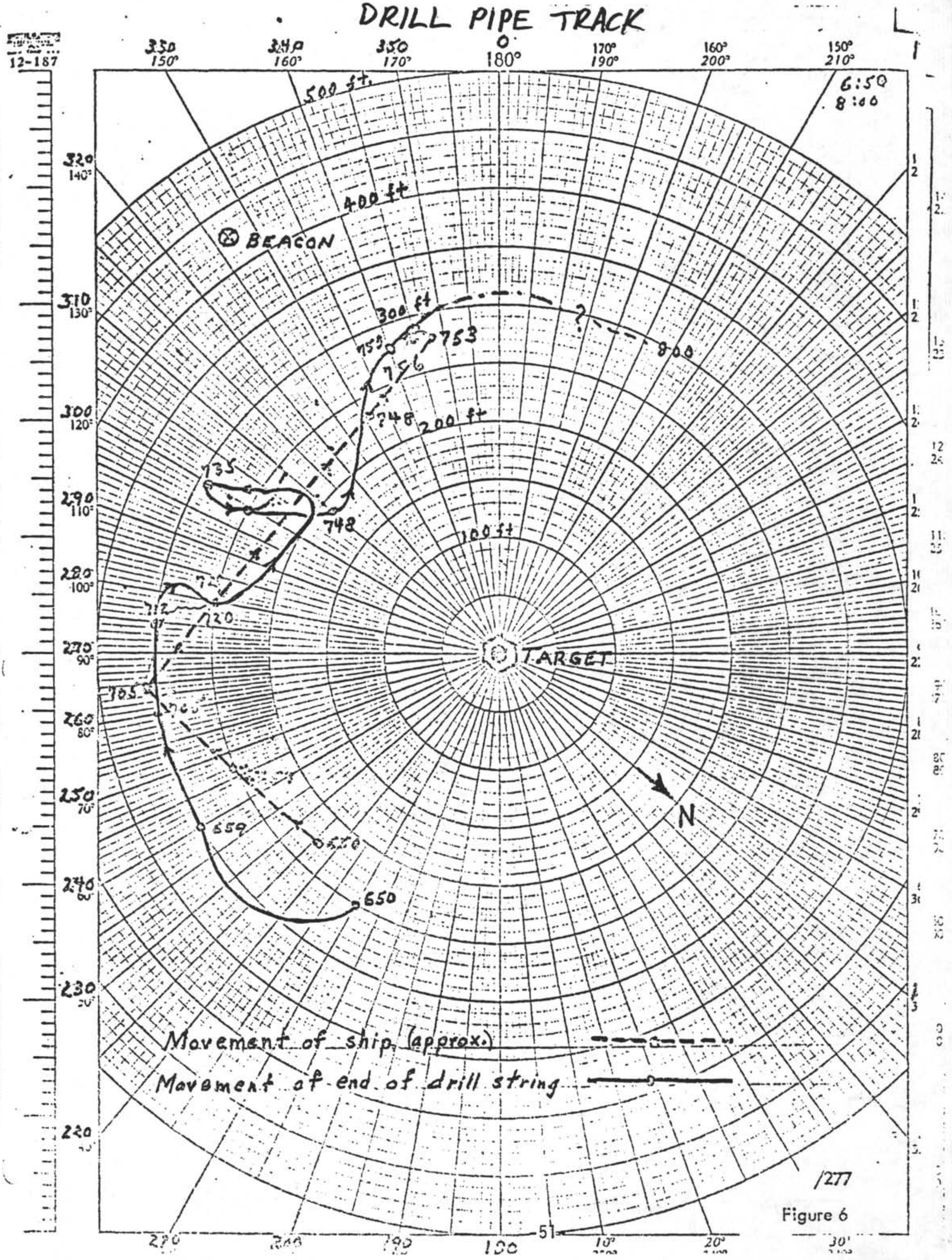

DRILL PIPE TRACK
1800
1954
120 ft.
100 ft.
80
60
40
20
1920
1960
1840
1930
1830
1850
1910
RE ENTRY SUCCESSFUL 1954
1938 REENTRY ATTEMPT NO-GO
N 90
1820
1940
1800
1810
180°
0

Figure 8


DRILL PIPE TRACK
12-187
150°
160°
170°
180°
190°
200°
210°
500 ft.
400 ft
300 ft
200 ft
100 ft
BEACON
TARGET
N
753
800
748
735
720
705
659
650
Movement of ship (approx.)
Movement of end of drill string

/277

Figure 6

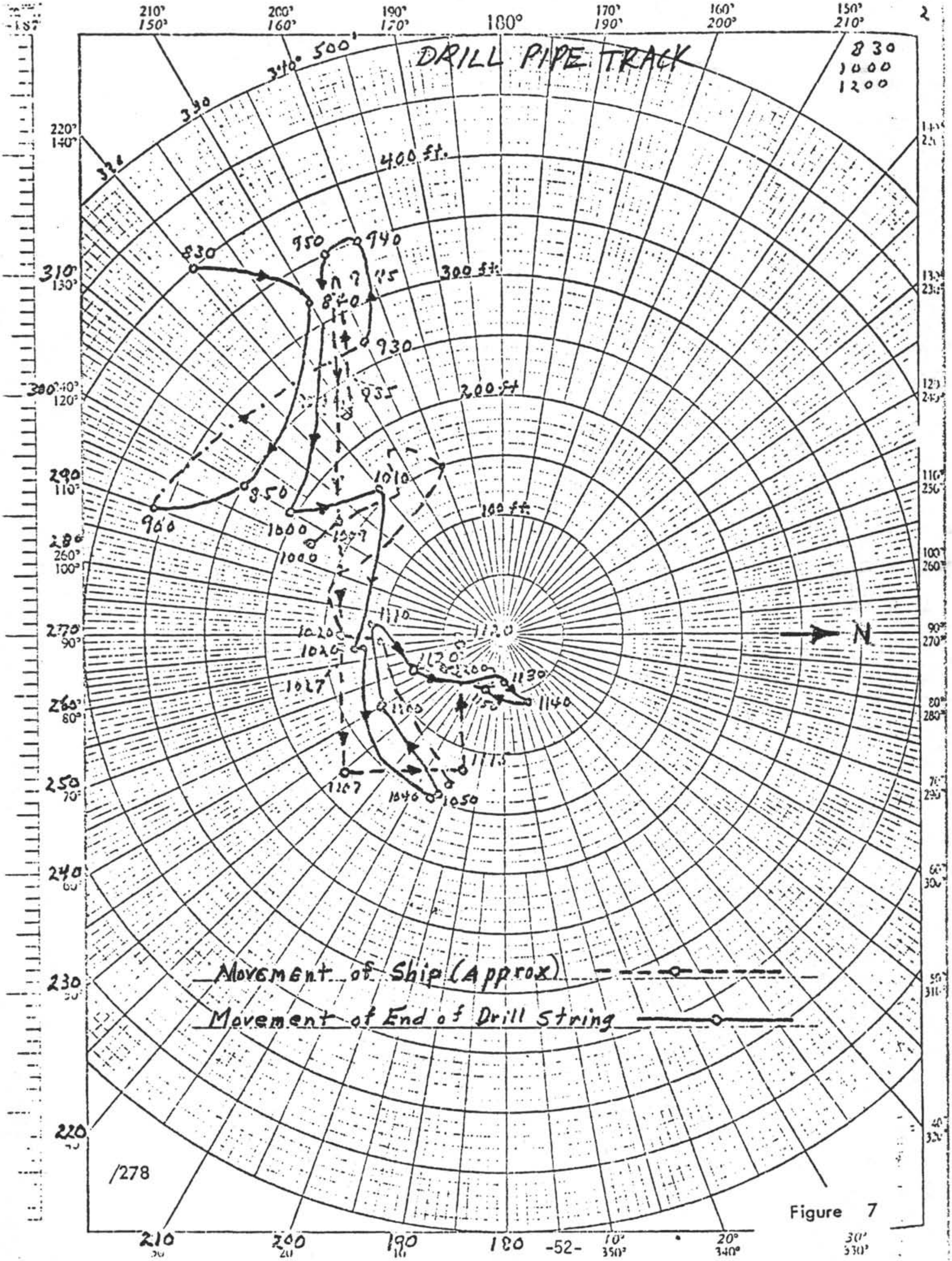

DRILL PIPE TRACK
830
1000
1200
500'
400 ft.
300 ft.
200 ft
100 ft.
N
Movement of Ship (Approx)
Movement of End of Drill String
830
840
850
900
930
935
940
950
1000
1010
1020
1027
1040
1050
1107
1110
1115
1120
1130
1140
1150
180°
170°
190°
160°
200°
150°
210°
/278

Figure 7

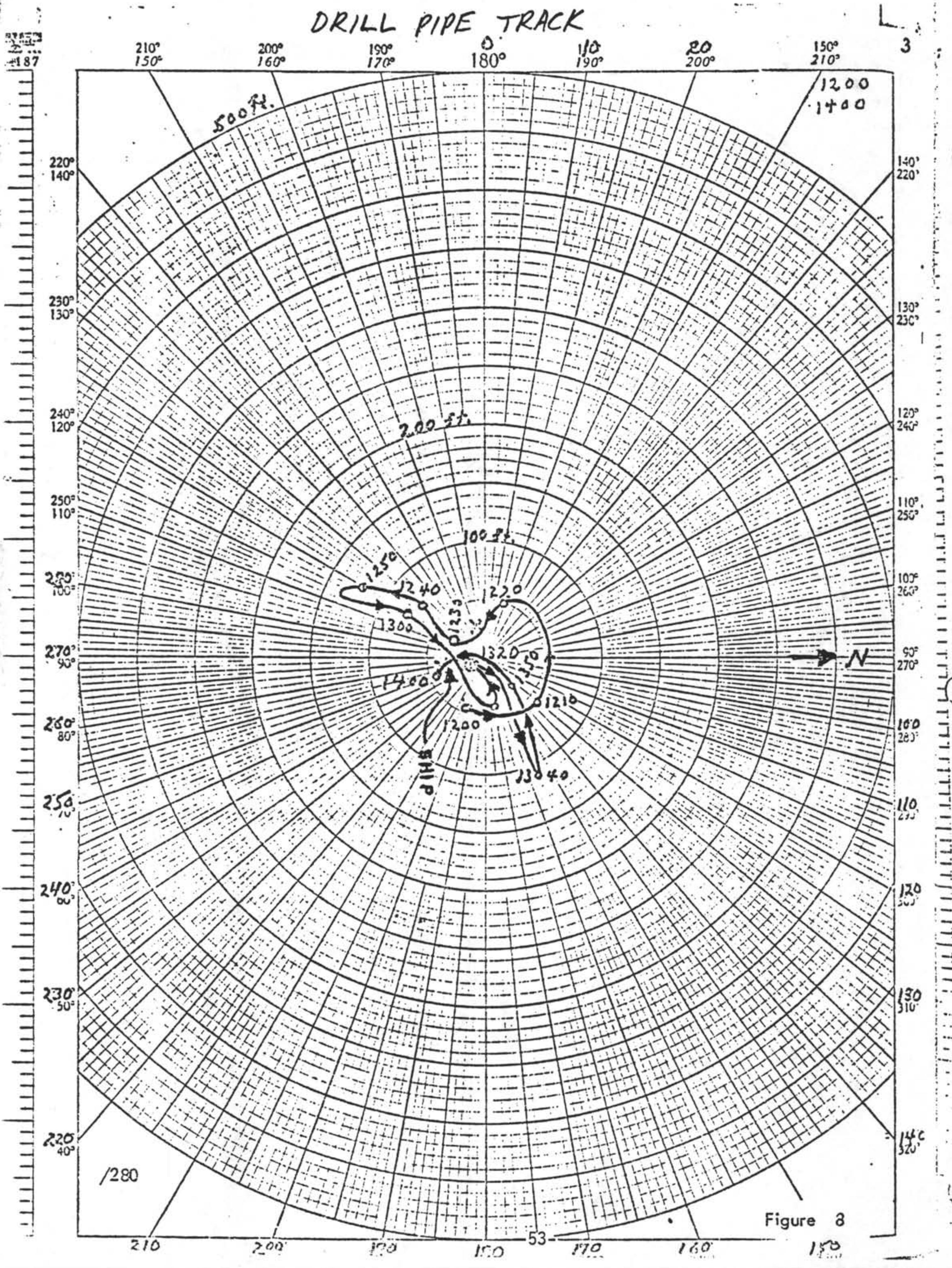

DRILL PIPE TRACK
500 ft.
200 ft.
100 ft.
1200
1400
1250
1240
1220
1233
1300
1320
1330
1400
1210
1200
1340
SHIP
N
/280

Figure 8

DRILL PIPE TRACK

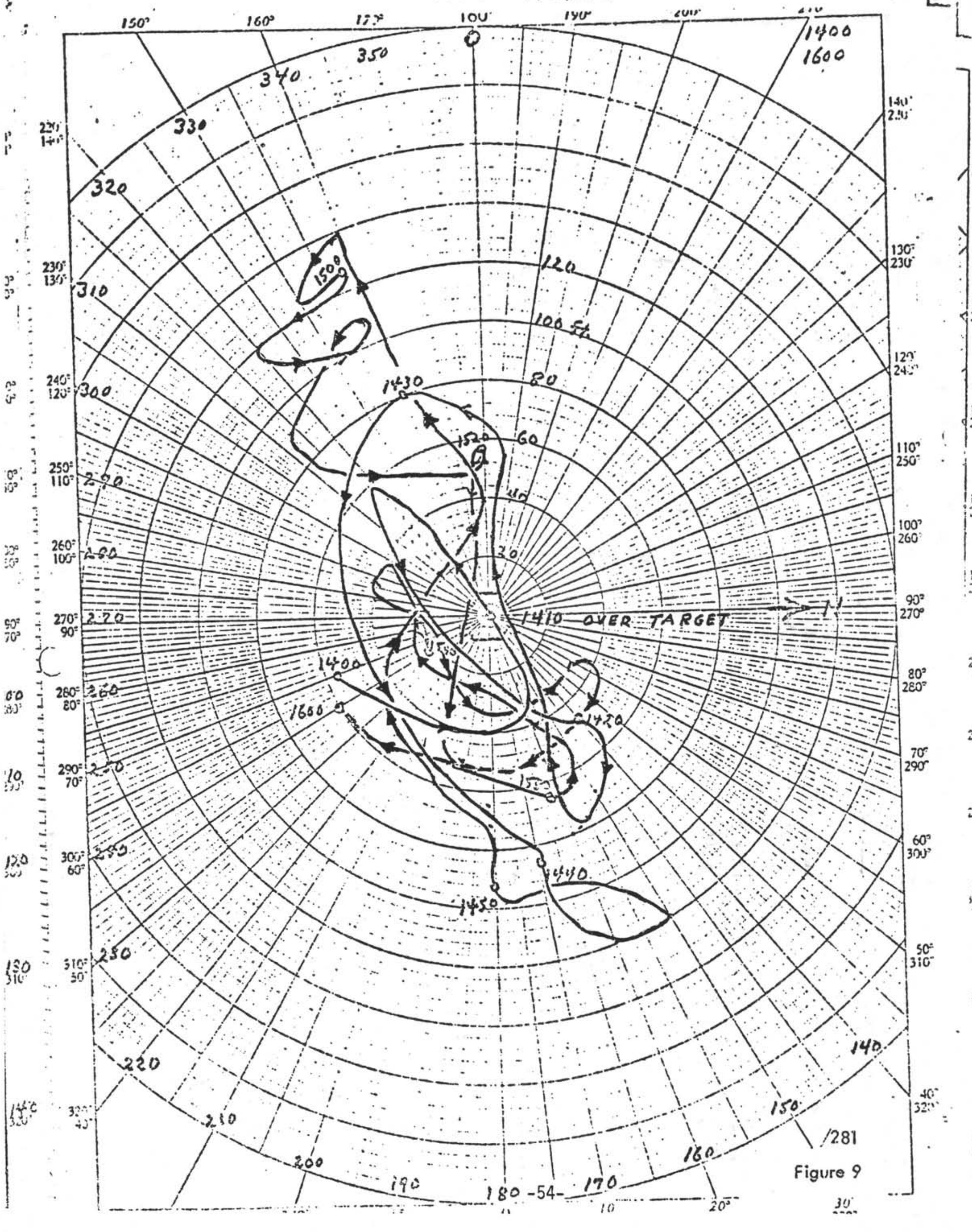


Figure 9

DRILL PIPE TRACK

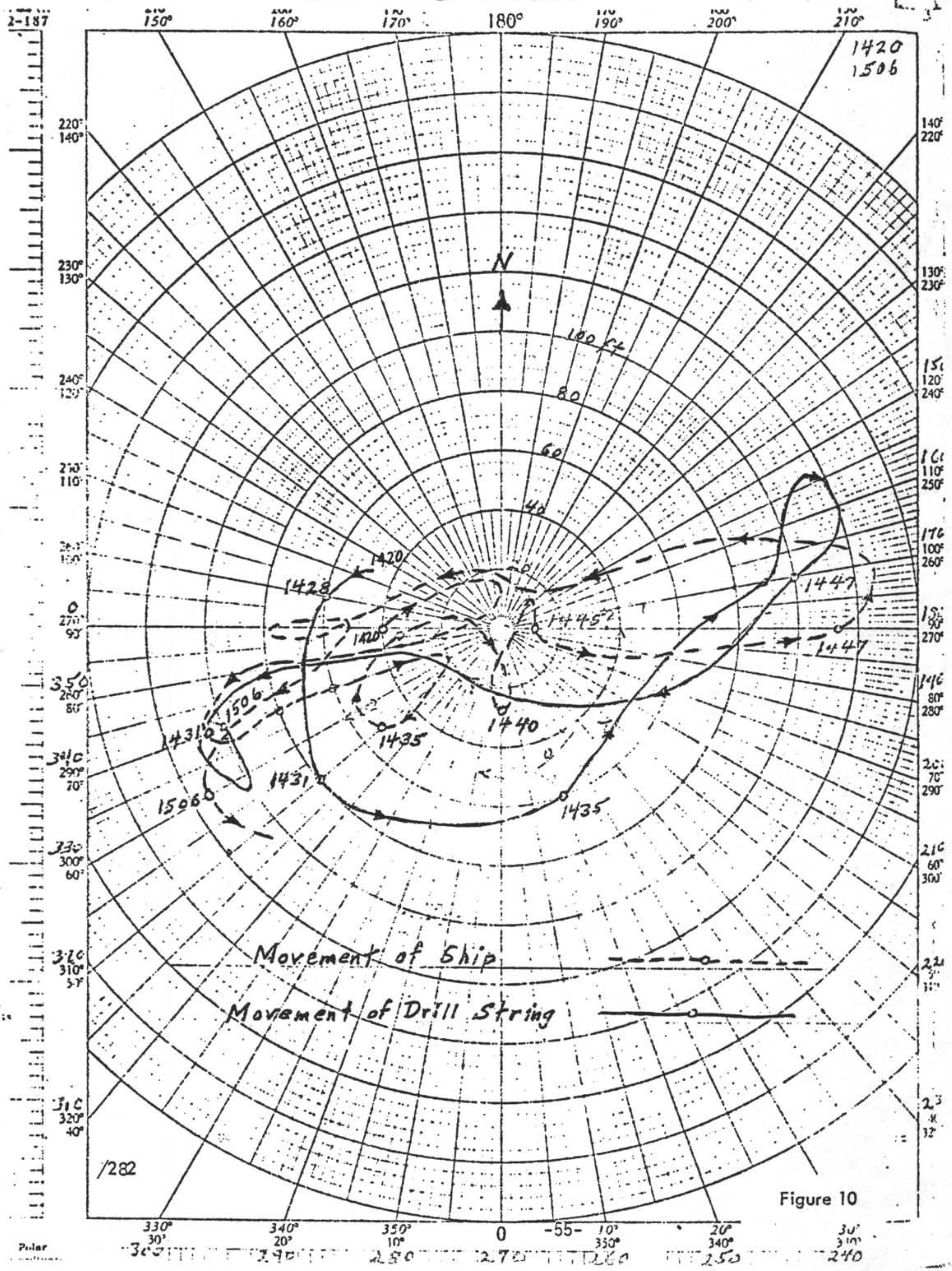


Figure 10

APPENDIX D

CONSTRUCTION OF LOGGING CABLE

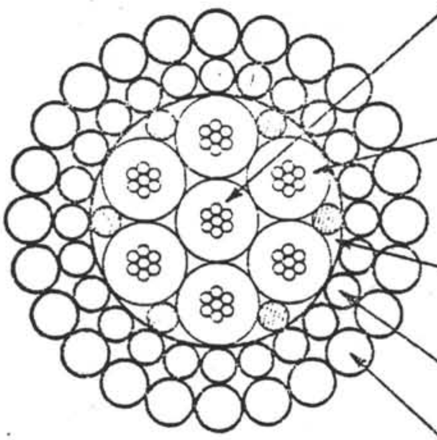
USED WITH

WIRELINE RE-ENTRY SYSTEM

PART NO. A20009

Description: TYPE: 7-J46RB (Old Type 7-46P)

15/32" SEVEN CONDUCTOR ARMORED CABLE. THIS CABLE IS DESIGNED AND SPECIALLY MANUFACTURED FOR USE IN OIL WELL LOGGING. IT IS WIDELY USED IN OCEANOGRAPHIC AND OTHER APPLICATIONS.



#20 AWG (6/.0142") copper. Nylon monofilament core. Ethylene Propylene Copolymer insulation. Nom wall = .026". O.D. = .094".

#20 AWG (7/.0126") copper. Ethylene Propylene Copolymer insulation. Nom wall = .027". O.D. = .092".

6-cotton fillers and conductive filler compound in interstices. Conductive Dacron binder. O.D. = .288".

24/.039" GIPS, RHL. O.D. = .366". (Inner

24/.049" GIPS, LHL. O.D. = .464". (Outer)

Armor wires are galvanized high tensile steel, preformed and prestressed. Armor is flooded with polar active asphaltic anti-corrosion compound.

Specifications:

MECHANICAL:

	In Sea Water:	282#/M'
Weight:	In air:	346#/M'
	In fresh water:	289#/M'
Breaking strength:	Ends fixed (min calc):	16,525#
	Ends free (min calc):	11,360#
Temperature rating:		-50°F to +300°F
Cable outside diameter:		.464"±.010"
Maximum end to end variation:		.010"
Recommended minimum sheave/drum diameter:		24"
Elongation:		.77'/M'/M#

ELECTRICAL:

See reverse side of page.

1-74

PART NO. A20009

ELECTRICAL:

DC resistance at 68°F:	Center conductor:	10.4 ohms/M'
	Outer conductors:	10.9 ohms/M'
	Armor:	1.0 ohms/M'
	Insulation (min at 500 VDC):	1500 megohms/M'
Capacitance at 1 KHZ:	Armor to outer conductors:	40 pf/ft
	Armor to center conductor:	45 pf/ft
Voltage rating:		1000 VRMS

Vector Cable Company, 555 Industrial Road, Sugar Land, Texas 77478

APPENDIX E

ENGINEERING REVIEW

OF A

WIRELINE RE-ENTRY SYSTEM

DEPARTMENT OF THE NAVY
NAVAL OCEAN SYSTEMS CENTER
SAN DIEGO, CALIFORNIA 92152

AJS:jec
3900
Ser 942/44
27 JUL 1983

From: Commander, Naval Ocean Systems Center
To: Deep Sea Drilling Project, A031, University of California, San Diego, La Jolla, CA 92093 (Attention: Ed Dean)

Subj: Engineering review of Wireline Re-entry System; submission of

Ref: (a) University of California purchase order G13483-3058

Encl: (1) Engineering Review of Wireline Re-entry System, by Applied Technology Division, Code 942, Naval Ocean Systems Center, dtd 21 Jul 1983

1. Enclosure (1) is forwarded to complete the requirements of reference (a).

A.J. SCHLOSSER
By direction

Enclosure forwarded (5 copies)

ENGINEERING REVIEW OF

A WIRELINE RE-ENTRY SYSTEM

BY

APPLIED TECHNOLOGY DIVISION

NAVAL OCEAN SYSTEMS CENTER

21 July 1983

Enclosure (1) to NOSC ltr
Ser 942/44 of 27 Jul 1983

I. TASK OBJECTIVES

The Naval Ocean Systems Center (NOSC), has been tasked by the Deep Sea Drilling Project to evaluate the technique of using a wireline re-entry system to re-enter existing deep ocean boreholes. Current re-entry techniques rely on the precise position keeping and maneuvering of a drill ship to position the end of a drill string within the borehole re-entry cone. Drill ships are inherently costly to operate and the use of such a unique platform severely limits the scheduling flexibility of user projects.

If a wireline re-entry scheme can be developed which is capable of being deployed from a less sophisticated, and therefore less costly and more readily available platform, then re-entry projects can be conducted at less cost with more freedom of operating area and scheduling. To achieve these goals, the primary objectives of the wireline re-entry system are: (1) provide a system which can meet operational objectives at minimum development cost and reduced operational cost and (2) be capable of operation from a variety of readily available platforms such as oceanographic vessels or commercial tug supply vessel types.

II. EVALUATION OF THE GLOMAR CHALLENGER AS A WIRELINE SUPPORT SHIP

First, it is recognized that the Glomar Challenger was utilized as the initial test platform for a wireline system to gain basic experience to guide further investigations and development. "A re-entry was not accomplished using Glomar Challenger due to malfunctioning of the Scan Sonar"[1] From the test data observed, it does appear that re-entry into a bore hole is feasible. As to the time required on station to accomplish re-entry, "the time lag during testing showed roughly twice that of the drill string."[1] However, if the wireline approach results in the need for a surface support platform with essentially all the sophisticated capabilities of a Glomar Challenger, save a drill string, very little overall cost saving will be realized. With this in mind, the emphasis in evaluating the wireline technique and suggesting possible approaches for improvement are slanted toward operational and system analysis rather than analytical analysis of the overall dynamics of the problem.

[1] "Interim Report, Wireline Re-entry System", by Donald R. Bellows, 22 Dec 1982

From the data presented, four areas are suggested for critical comment. They are:

A. Ability to predict cable end track or guide a cable to the cone based on test data of ship track vs cable track

B. Cable dynamics (both theoretical and empirical) as related to a need for precise station keeping

C. The use of the existing logging cable vs a cable configuration designed specifically for the tasks

D. The use of the moon pool for launch and retrieval.

SHIP TRACK VS CABLE END TRACK

The report by D. R. Bellows[1] presents a description of sea tests conducted in September 1982 from the Glomar Challenger with plots of ship track and cable end track. From examining the behavior of the cable end track relative to ship track, it is very difficult to develop a coherent picture for a method of ship maneuvering which will create precise and predictable movement of the cable end in order to acquire a 15' diameter re-entry cone. For a purely ship controlled cable positioning approach two (2) methods appear feasible. First, have a ship capable of precise station helping (within 15' diameter) for periods long enough to achieve equilibrium of the cable shape; and second, start from a point far away from the cone, begin transiting to the cone so that course corrections can be made enroute soon enough to achieve equilibrium thereby affording a reasonable chance of flying over the cone. The first option is not cost effective because of the elaborate station keeping and position sensing required and the second option would likely require an inordinate amount of ship time to achieve a successful fly over.

CABLE DYNAMICS AND STATION KEEPING

Based on the arguments just mentioned about actual cable dynamics test data and the study conducted by W. Nugent and Associated Engineers, it appears that a very precise station keeping and position sensing (both ship and cable and relative to re-entry cone) capability is imperative to reacquiring a re-entry cone by an unassisted cable. Although only limited time was available to conduct the wireline experiment with the Glomar Challenger, more time may have produced some insight into what actions could produce the most desirable cable motions. Even so, it appears that the station keeping requirement would be at least as stringent as the capability of the Glomar

Challenger if not greater.

LOGGING CABLE

While the logging cable provided a readily available means of conducting the test at no capital investment, its use severely limits data and power transmission flexibility. The cable system for a wireline re-entry system should be a separate development item with performance requirements dictated by mission objectives. From this, a detailed cable specification can be developed, which will maximize system reliability and effectiveness at minimum cost.

MOON POOL

A major advantage of the moon pool technique is placing the load handling point at the minimum motion location on the ship. However, ships of opportunity seldom have a moon pool. Furthermore, handling operations may be complicated by the restrictions of launching and retrieving through a moon pool.

III. ARGUMENTS TO SUPPORT CABLE END CONTROL

As mentioned in the tasks objectives, the wireline re-entry system must be achievable at a reasonable cost and provide a significant operational cost savings over drill ship operations. The information in Table 1 compares daily lease costs (based on FY81 figures) for a variety of classes of ships which are capable of supporting deep ocean operations similar to the wireline re-entry system. The salient point to be taken from this information is that very significant cost savings may be realized by using any of the vessel types other than drill ships. However, although many of the vessels have bow thrusters, very few except the drill ships have a true station keeping capability. Therefore, the use of one of the less expensive platforms indicates the need for some method of cable control which is not ship dependent. A proven (although for different applications) method of obtaining controllable cable dynamics in the deep ocean is by providing thrusters at or near the terminers of the cable. The Naval Ocean Systems Center has several years experience in both developing and operating deep ocean remote operated vehicles (ROVs). The CURV III vehicle has been successfully operated to depths of 6,300 feet to perform a variety of intricate underwater tasks. One fact has been clear in planning all such operations: as depth increases the effect of cable drag on vehicle maneuvering increases and adequate station keeping becomes more important. These operations are generally conducted from a ship of opportunity such as a twin screw ARS, ASR or TATF (which also has a bow thruster) and they have proven to provide the necessary maneuverability and station keeping.

For operations beyond 7,000 feet, the Naval Ocean Systems Center developed the Remote Unmanned Work System (RUWS) technology. This system is designed for operations to 20,000 feet. During the concept development phase of this project, it was determined that a heavy cable end termination with thrust capability would provide the most advantageous method for de-coupling the vehicle from cable dynamic effects. In actual practice, the system performed as designed and afforded a high degree of maneuverability and precision positioning of the near neutrally buoyant RUWS vehicle. Based on the aforementioned experience, the ability to actively maneuver the wireline lower end appears highly desirable.

Based on the mission requirements of a borehole re-entry device, the sensor and effector requirements appear quite manageable and much less demanding than those required for a CURV or RUWS system. Little more than the existing re-entry sensors should be needed and thruster/maneuvering requirements appears to be well within current state-of-the-art.

From the mission profile used in the wireline exercise conducted in September, 1982, it is possible to develop an assumed operational scenario for a wireline system with thrust capability. From this scenario, the major system parameters can be specified and used to further refine the operational scenario are:

A. Sensors
B. Effectors
C. Data/Control
D. Pack Power and Energy.

From this initial performance requirement, an engineering trade off may be conducted to determine optimum system specifications.

ENGINEERING TRADE-OFFS

In order to develop a comprehensive system specification, each major design area must be examined in sufficient detail in order to choose the most appropriate approach. Since it can be argued that any of the vessel types listed in Table 1 will provide a suitable surface support platform for the wireline with Thrusters approach and that drill ships should be excluded based on operating cost, the modified wireline system can be separated into three major subsystems. They are:

A. Navigation and position

B. Thrusters

C. Tether.

One additional area which should be considered after the basic system specification is developed is additional sensors which may improve or enhance operational techniques. These additional sensors should be evaluated on a cost benefit/technical risk basis..

NAVIGATION AND POSITION

The key to successful re-entry is based on accurate and timely position information and an ability to predict and effect appropriate actions. Since the intent of the system proposed here is to be operable from a variety of support ships, actual navigation is of only secondary importance and position relative to the borehole or a fixed point within some reasonable distance of the borehole is imperative. Therefore, the navigation system must be accurate enough to acquire the operating site and establish the positioning system which will provide accurate fixes of both the cable end and ship relative to a bottom located datum. The more complex job of providing position information includes both an acoustic positioning grid and cable end sensors capable of detecting and classifying ocean bottom targets.

THRUSTERS

Thrust configuration and magnitude requirements can be developed from ship station keeping capabilities* and cable forces effecting the cable end position. Following this, the options to consider are:

A. Electro hydraulic vs electric--including poser and control implications

B. Thrust and duty cycle requirements--defined from operating scenario

C. Control scheme--proportional vs on/off vs automatic from sensor feedback

D. Configuration--on re-entry package vs up cable.

TETHER

The addition of thrusters and the increased requirement for control and data transmission over the wireline support tether suggests a cable with

* From CURV III experience, it is logical to assume that by prudent heading and maneuvering of a twin screw ship a watch circle of no more than 500 feet radius may be maintained up through sea state 4.

greater complexity than a standard logging cable. The three main considerations for this cable are strength, data and power transmission. Tether strength can be achieved by wire or synthetic fibers including the newer Kevlar. The choice should take into account cost, handling ease, reliability and availability. Date transmission will be greatly influenced by the choice of multiplexing or hard wire approach. Power transmission requirements will be determined by power and duty cycle requirements and the choice will take into account voltage/current trade-offs and effects on down cable equipment.

ADDITIONAL SENSORS AND REFINEMENTS

One final addition which may be considered at this point is the use of positive down hole sensors or a scheme for inferring this from other system sensors and status. As the optimum system evolves, other sensors may be suggested.

RECOMMENDATIONS

As a result of studying the test data from the wireline re-entry test conducted in September, 1982 and comparison with drill string re-entry techniques, a system centered approach which affords some freedom in the choice of operating platform, is recommended. This approach necessitates positive cable end control and real time high accuracy position information. It is further recommended that the proposed system trade-offs be performed to a level of detail that will allow development of a reasonable operating scenario and cost estimates (both system development and operating costs) of a system that will meet project objectives.

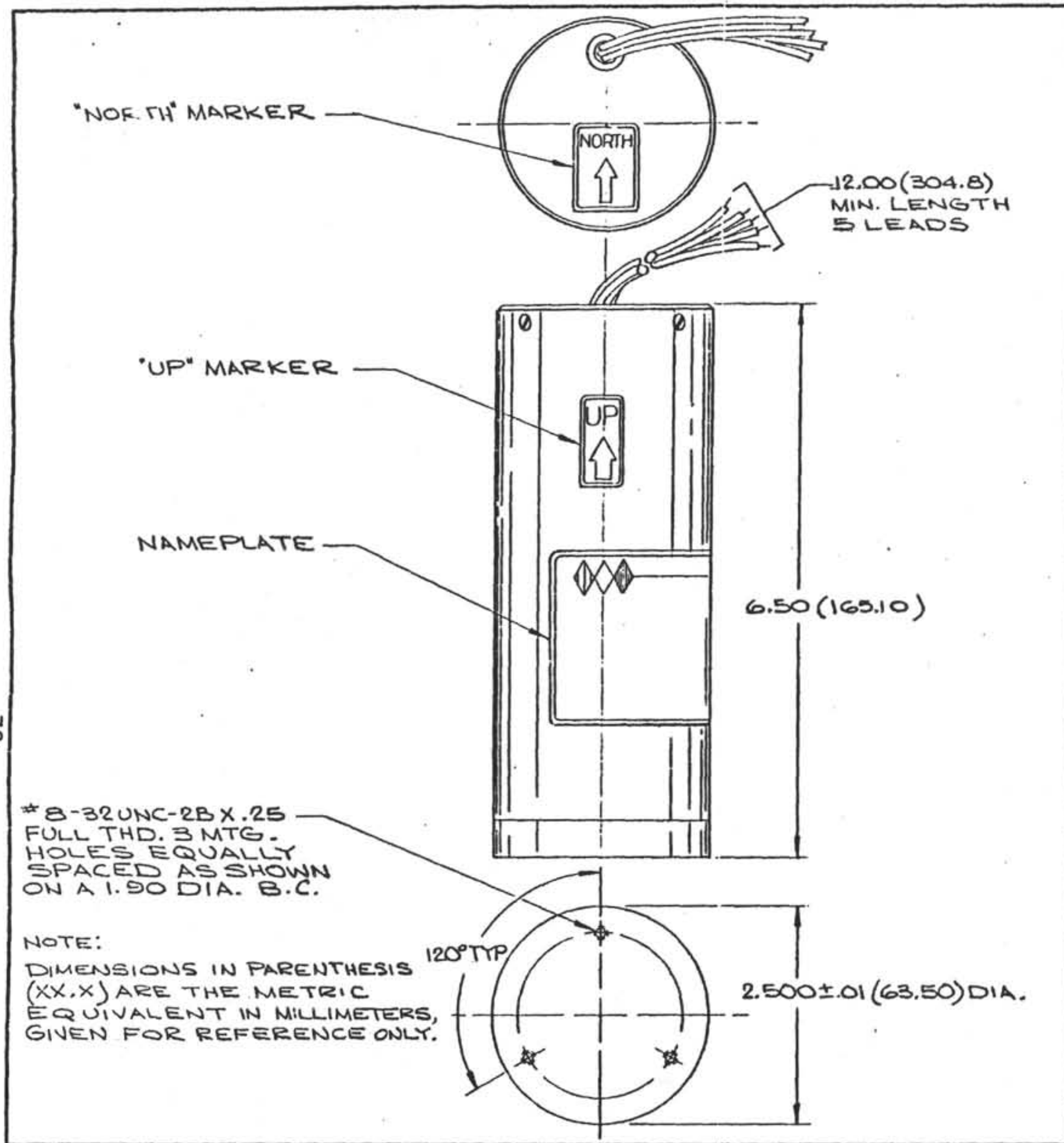
TABLE 1 SHIP LEASE COST COMPARISON

FOR FY 81

	COST/DAY $K
GLOMAR CHALLENGER	30
GLOMAR ATLANTIC	92
GLOMAR PACIFIC	97
FRENCH DRILL SHIPS	75
SEDCO 707	110
SORCAS	85
OFF SHORE TUG SUPPLY VESSEL	3
NOAA AGOR TYPE	6
GENERAL OCEANOGRAPHIC RESEARCH VESSEL (SCRIPPS)	6-11
OCEANOGRAPHER OF THE NAVY VESSELS (FREE DEPENDENT ON SCHEDULING)	

APPENDIX F

HUMPHREY NORTHSEEKER



SPECIFICATIONS

1.0	MECHANICAL FREEDOM	
1.1	AZIMUTH	360° CONTINUOUS
2.0	AZIMUTH POTENTIOMETER	
2.1	RANGE	358° ±1°
2.2	POTENTIOMETER	10K ±5%
*2.3	ACCURACY (INCLUDING LINEARITY AND HYSTERESIS)	VERTICAL ±2.0°, AT 30° S.A. ±2.5° AT 45° S.A. ±3.0°
2.3.1	SLAVE, RATE	2.0 R.P.M. MAXIMUM
2.4	SLANT ANGLE RANGE	0 TO 45° (UNIVERSAL JOINT)
3.0	INPUT POWER	
3.1	INPUT VOLTAGE	26 VDC ±2 VDC
3.2	POWER (ACROSS POT.)	.3 .6 VDC
3.3	MAXIMUM START UP TIME PROBE ON SURFACE	1 MINUTE
4.0	INSULATION RESISTANCE	50 MEGOHMS MINIMUM BETWEEN ANY PIN AND PROBE WITH 500 VDC APPLIED
5.0	SEALING	INSTRUMENT MUST BE INSTALLED IN PROTECTIVE HOUSING FREE OF MOISTURE AND DUST
6.0	SERVICE LIFE	500 HOURS
7.0	ENVIRONMENTAL CONDITIONS	
7.1	TEMPERATURE	0 TO 125°C
7.2	VIBRATION	7.5G 5 TO 200 HZ
7.3	SHOCK	100G 10 MILLISECONDS RISE TIME
7.4	WEIGHT	2 POUNDS APPROX.

*ACCURACY TOLERANCE APPLIES WHEN OUTPUT IS CORRECTED FOR UNIVERSAL JOINT ERRORS. USE FOLLOWING FORMULA TO APPLY CORRECTION:

$$T_N = \mathrm{TAN}^{-1}\left[\mathrm{TAN}\,(\psi_B + T_{IN})\,(\cos\psi \quad \sin\psi_B)\,\cos\,(\psi \quad \cos\psi_B\right] - \psi_B$$

TRUE SLANT ANGLE BEARING $\psi_{BN} = T_N \quad + \psi_B - 180)$, IF ≥ 360 SUBTRACT 360

NOTE: ALL ANGLES ARE MEASURED CLOCKWISE:

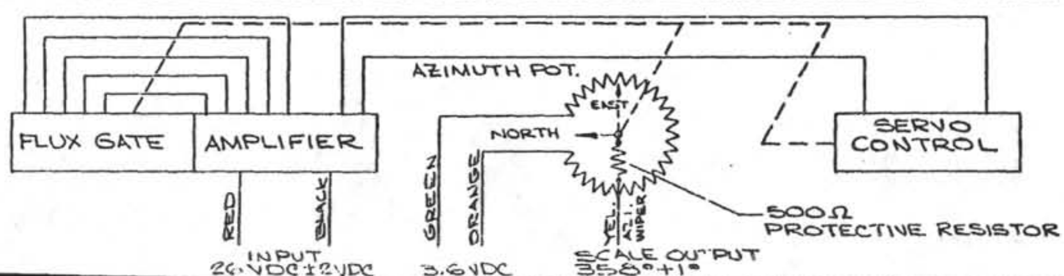
T_{IN} = INDICATED TOOL FACE FROM NORTH

ψ_B = RELATIVE BEARING FROM INDICATED TOOL FACE TO LOW SIDE OF PROBE

ψ_{BN} = SLANT ANGLE BEARING FROM NORTH TO HIGH SIDE OF PROBE

ψ = SLANT ANGLE OR INCLINATION ANGLE OF PROBE

T_N = CORRECTED TOOL FACE FROM NORTH



REVISIONS (SEE DCN)				DWG CL	BY	DATE
A	L.C	4/13	85	1		
				2	LC	4/13/85
				3		
				4		
				5		

CUSTOMER REF MATL

Humphrey Inc. SAN DIEGO, CALIFORNIA — ELECTRO-MECHANICAL INSTRUMENTS

TITLE ENVELOPE DRAWING. NORTH SEEKER

DRAWN BY L. COOK

CHECKED BY

DESIGN ENGR

UNLESS OTHERWISE SPECIFIED LIMITS ON DIMENSIONS ARE DECIMAL .XX ±.03 .XXX ±.010 ANGULAR ±1/2°

SCALE 1/1 — DWG SIZE C — MODEL NO NS13-2201-1 — CODE IDENT NO 98284 — REV LTR A

APPENDIX G

OPERATION OF NORTHSEEKER

TO

DETERMINE BEARING OF RE-ENTRY CONE

Figure G1 shows the display presentations that are used during a sireline re-entry operation. Figure G1(a) is the presentation for the long range maneuvering where the ship's position is at the center of the screen. When the dynamic positioning system is switched over from the bottom beacon to the tool beacon the necessary heading can be determined that will bring the tool toward the re-entry cone. During the short time of the switchover, the ship will not be able to keep station and will tend to drift. However, this should not present a great problem since the ship will start steaming on a course as soon as the location of the tool is determined. Figure G1(b) is the presentation from the scan sonar and is used for the short range maneuvering once the cone has been detected. With the aid of the compass in the tool the rotation rate of the tool and the bearing of the cone relative to the tool can be determined as follows:

Let R_T = rotation rate of entry tool package

R_s = rotation rate of sweep on display of Figure 4(b) (this is also rotation rate of transducer in scan sonar)

t_s - time for 360^o sweep on display

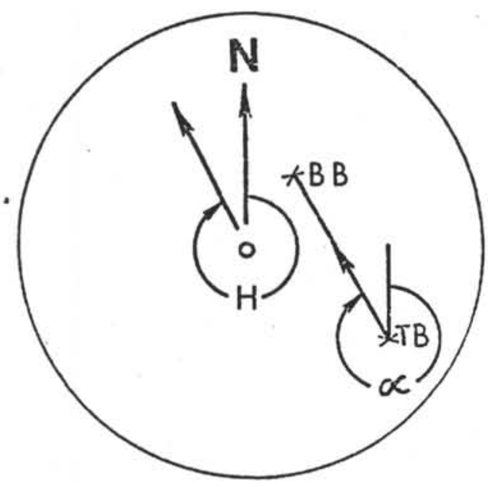
B = actual bearing of cone relative to tool

Then

$$R_T = R_s \frac{360}{\beta} - 1$$

$$B = \frac{(360)^2 B_o}{R_s \beta t_s}$$

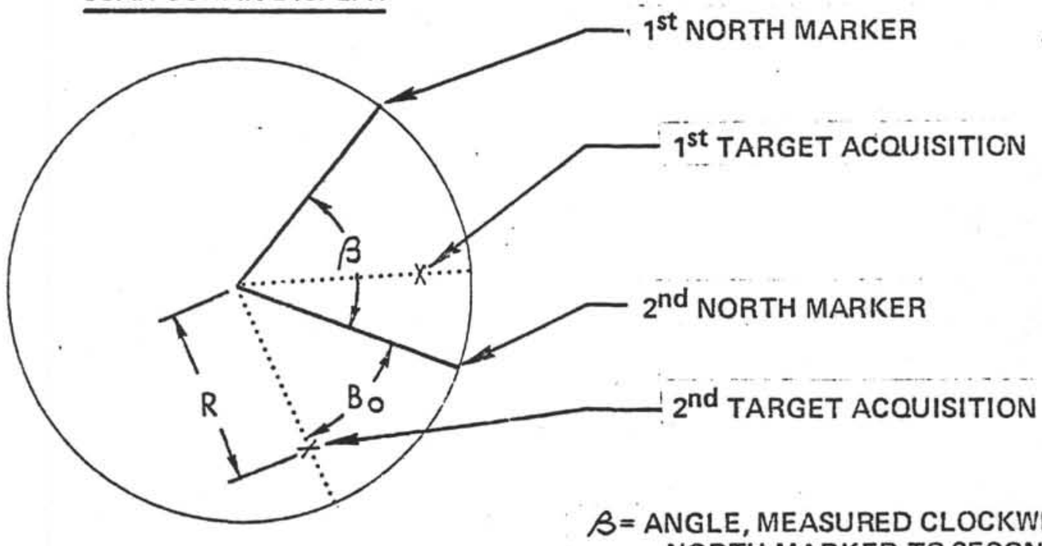
DYNAMIC POSITIONING DISPLAY



BB = POSITION OF BOTTOM BEACON JUST BEFORE SWITCHOVER
TB = POSITION OF TOOL BEACON JUST AFTER SWITCHOVER
∝ = BEARING OF TOOL FROM BOTTOM BEACON
H = SHIP'S HEADING = ∝

(a)

SCAN SONAR DISPLAY



β = ANGLE, MEASURED CLOCKWISE, FROM FIRST NORTH MARKER TO SECOND NORTH MARKER
B_o = OBSERVED BEARING OF TARGET FROM TOOL
R = RANGE OF TARGET FROM TOOL

(b)

FIGURE G1