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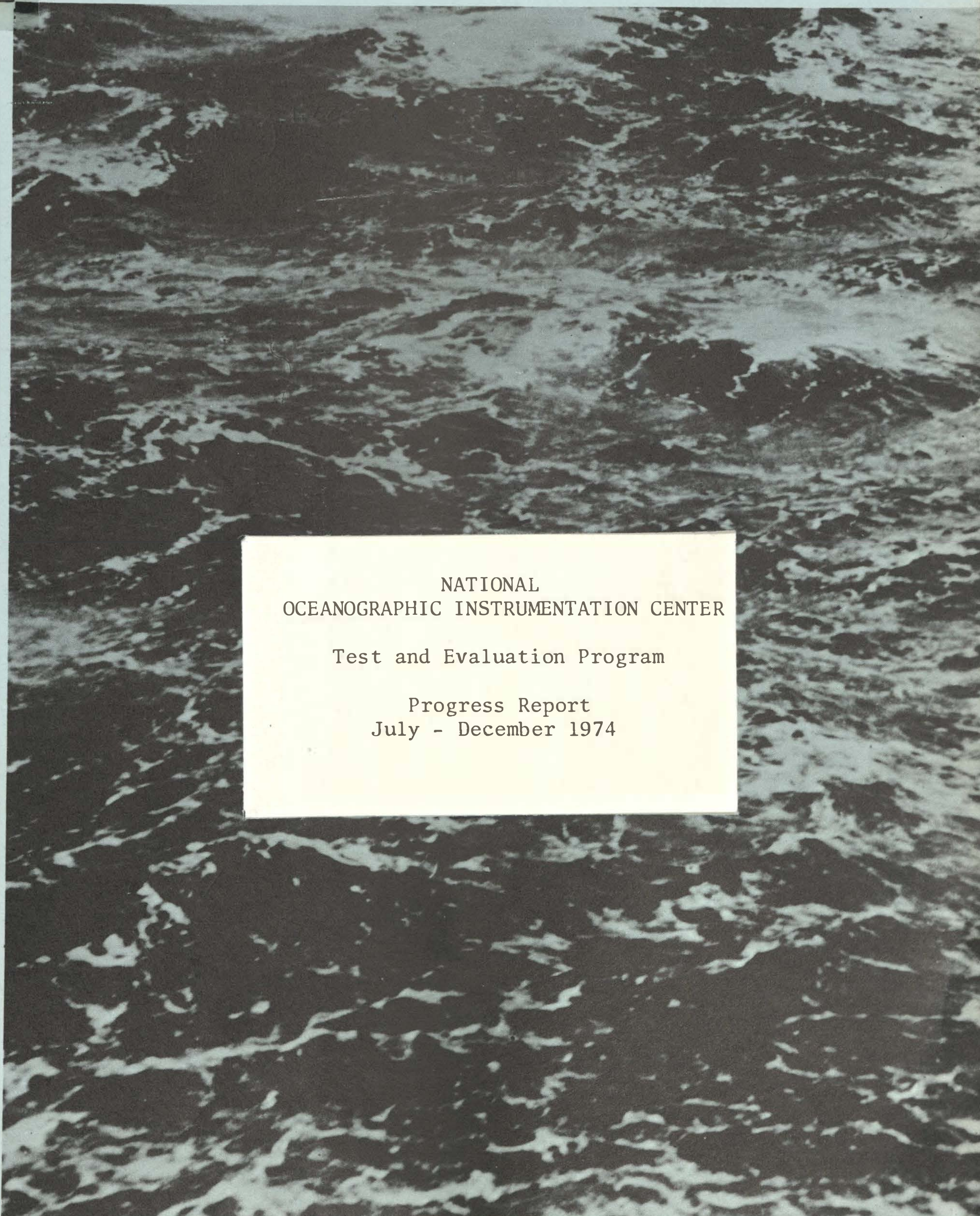
National Oceanographic Instrumentation Center

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Ocean Survey



NATIONAL
OCEANOGRAPHIC INSTRUMENTATION CENTER

Test and Evaluation Program

Progress Report
July - December 1974

National
Oceanographic
Instrumentation
Center
HINGTON, D.C.

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Approvals:

Luther E. Bivins
Chief, Testing Division

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January 1975

INTRODUCTION

The objective of the National Oceanographic Instrumentation Center's (NOIC) Test and Evaluation Program is to provide information on the state of marine instrument technology. This information can serve as a basis for decisions influencing positive direction of programs which utilize marine instruments and thus result in favorable changes.

The progress report provides summary descriptions of marine instrumentation undergoing test and evaluation at NOIC during the period from July 1, 1974 to December 30, 1974. The instrumentation are divided into the following five broad categories:

- Acoustic Instrumentation
- Chemical/Biological Instrumentation
- Conductivity/Salinity-Temperature-Depth Measuring Systems
- Current Measuring Instrumentation
- Wave and Tide Measuring Instrumentation

The instruments covered in this report are of general interest to the entire marine science community and of specific interest to many programs. As indicated by the asterisks in the table of contents, the majority of the instruments tested are of specific interest to the Navy and their selection was based on requirements conveyed to NOIC by the Office of the Oceanographer of the Navy.

Should anyone desire additional information concerning the evaluation of the instruments listed in this report, please contact NOIC's Testing Division, Code C631, Rockville, MD 20852 (Phone 202-426-9073 or 202-426-9075).

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ACOUSTIC INSTRUMENTATION

TESTING PROGRAM

Date: January 1, 1975

Project: Acoustics
Project Leader: K. Berstis

N — Navy R — Reimbursable
I — In-House O — Other

Task Description	FY'75 J	A	S	O	N	D	J	F	M	A	M	J	FY'76 J	A	S	O	N	D	J	F	M	A	M	J	Req'mt.
Acoustic Release Systems																									
AMF Sea Link 301 / AMF 322 Release	■	■	■	■					■	■															N
Marine Resources Release				■	■	■	■	■	■	■	■														N
AMF 284 Release Pinger																									N
Correlation Echo Sounder Processor																									
Raytheon CESP-I	■	■																							N,I
Bottom/Subbottom Profiling Systems																									
Raytheon UGR-196C	■	■	■	■	■	■	■																		N
InterOcean Systems 3000																			■	■	■	■	■	■	N
Raytheon RTT-1000																	■	■	■	■	■	■	■	■	N
Side Scan Sonar																									
Klein Associates MK-300															■	■	■	■	■	■					N
Current Meters																									
NDBO Acoustic Doppler Meter						■	■																		R

TESTING PROGRAM

Date: January 1, 1975

Project: Acoustics

Project Leader: K. Berstis

N — Navy R — Reimbursable
I — In-House O — Other

Task Description	FY'75												FY'76												Req'mt.
	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	
Transponder Navigation System																									
AMF ATNAV																							X	X	N
Digital Trackers																									
General Instruments																		X	X	X	X	X	X	X	N
Edo Western 261C												X	X	X	X	X	X	X							N,I
Raytheon PDD-200C																	X	X	X	X	X	X	X	X	N
Innerspace Technology Models 410 & 408																		X	X	X	X	X	X	X	N

AMF (301-322) RECOVERABLE ACOUSTIC TRANSPONDER/RELEASE SYSTEM

A. Description

The AMF Model 301 range/bearing acoustic relocator (shipboard unit) and the Model 322 recoverable acoustic transponder release device (underwater unit) comprise a remote control acoustic release system.

The Model 301 range/bearing acoustic relocator provides a display of bearing angle and slant range to the underwater unit. The bearing angle accuracy is specified to ±5° and the timing error in the slant range is specified to ±0.5 milliseconds. In addition the associated peripheral shipboard equipment (Model 200 Coder and Power Amplifier) can release up to ten underwater devices separately. The Model 322 recoverable acoustic transponder release device features a -15 db re 1 microbar receiver sensitivity in the release mode and a source level of 89 db re 1 microbar at 1 yard at 10 kHz in the transponder mode. The Model 301 is powered by 115 V., 60 Hz power supply while the Model 322 is self-contained utilizing batteries having a shelf life of 1 year.

B. Progress

The evaluation of this acoustic release system is 90% complete. Field tests were conducted aboard the NOAA Ship GEORGE M. BOWERS in July 1974 and maximum detectable transponder and release ranges were determined for the (301-322) system in two shallow water and one intermediate depth (5,000 ft.) deployments. During the third deployment, the AMF Model 322 release (S/N 332) failed to release on command and could not be recovered. In addition, another mooring with the other AMF Model 322 release (S/N 331) failed to surface although both the primary and the backup release did indicate that they opened on command. For this mooring possible anchor line fouling is presumed and a recovery operation for both moorings is planned in February 1975 aboard the NOAA Ship OREGON II.

C. Future Plans

The evaluation is planned for completion in April 1975.

The remaining tests to be completed on the AMF system after the recovery operation are timing stability, signal-to-noise ratio (SNR) and vibration. An Instrument Fact Sheet will be written summarizing the laboratory and field tests.

MARINE RESOURCES MODEL 096R DEEP SEA ACOUSTIC RELEASE TRANSPONDER

A. Description

The transponder consists of a pressure housing with outboard transducer and activation magnet and in board electronics and battery pack. In the Interrogation Mode, the unit responds to a 13 kHz 10 msec pulse and replies with a 13 kHz 15 msec pulse. Instead of 13 kHz, the receiver frequency can be specified as 11, 11.5 or 12.5 kHz. The release mode is activated by modulating the interrogation frequency with a square wave (100% modulation) and 50% duty cycle. The square wave modulation rate is 136.5 Hz but can also be specified at 123.0 Hz or 151.4 Hz. When the release command is received, an electrical potential is applied to the trip-wire holding a double arm, captive-link release mechanism. The potential produces electrolytic deposition of the trip-wire onto a return cathode and after approximately 3.5 minutes the wire is etched away, freeing the arms and link to which the anchor line is attached. During the period while the trip-wire is under electrolytic decomposition, the unit will reply to interrogation with a double pulse (0.5 sec spacing).

B. Progress

The evaluation of this release is 45% complete. Field tests were conducted aboard NOAA Ship GEORGE M. BOWERS in July 1974, and the Marine Resources Acoustic Release system was compared to the AMF (301-322) system in one shallow water deployment. This system did not have a digital range capability but in the audio mode compared favorably in maximum detectable range with the AMF system.

Instead of digital range output, the Marine Resources shipboard system has two logic output BNC connectors, one of which generates a 5 volt logic pulse when the transponder interrogate button is pushed and the other, a similar logic pulse, when the return signal is received. These outputs which are also connected to LED lamps can be used to measure the time interval between the shipboard transmit and the release transponder receive signals and can be converted to digital range information. A problem was noted with the receive logic output when a counter and tape recorder were connected to this jack. The receive LED lamp would turn on frequently in a random manner and a logic pulse would be generated that was completely unrelated to the received signal. This problem could be corrected by modification of the logic output circuitry.

During the intermediate depth deployment, no response was received from the release transponder (S/N 8) at the first test point 1/2 nautical mile from the mooring and the unit was assumed to have failed. The failure may be related to the problem with the O rings noted in the previous update which may have caused flooding of the pressure case. This release was also on the mooring which did not surface and is scheduled for the recovery operation in February 1975. Another unit

(S/N 1) has been received from the Naval Research Laboratory and the laboratory evaluation is underway. The final acceptance tests as specified by the manufacturer have been completed indicating that this unit was completely operational prior to the start of the laboratory evaluation. Receiver threshold versus input signal as a function of power supply variation and the input/output transfer function curves as a function of power supply variation have been determined for this acoustic release.

C. Future Plans

The laboratory evaluation for the Model 096R Deep Sea Acoustic Release Transponder (S/N 1) is scheduled to be completed in June 1975. An Instrument Fact Sheet will be written summarizing the laboratory and field tests.

AMF MODEL 284 ACOUSTIC RELEASE/PINGER

A. Description

The Model 284 consists of a release and pinger in a single pressure housing. The pinger replies acoustically for approximately one minute when interrogated with an AMF shipboard system or pings continuously upon executing the release command for the life of the battery. The load capability of the release is 1,000 lbs. and the maximum operating depth is 3,000 ft. The receiver section of this release is identical to the Model 322 release and the Model 284 is normally used with the AMF Model 200 Shipboard System. The release can be cocked externally and redeployed without opening the pressure case a minimum of 50 times over a 1-year period.

B. Progress

The unit is in-house but the evaluation has not yet started. Reliability reports on a Model 284 with an exploding bolt have been received from NOS ships indicating several problem areas. These problems may result in the unit being returned to the manufacturer for modifications prior to the evaluation.

C. Future Plans

The evaluation is scheduled to start in July 1975 and may be completed in January 1975. A field test will be scheduled for this unit after the completion of the laboratory evaluation and an Instrument Fact Sheet will be written summarizing laboratory and field tests.

RAYTHEON MODEL UGR-196C UNIVERSAL GRAPHIC RECORDER

A. Description

The Universal Graphic Recorder is designed to meet a variety of recording needs such as echo soundings, marine and land seismic profiles, and sonar or radar data. Some standard features of the recorder are: five discrete, switch-selectable line densities; full 60-cycle tape compatibility; past record review while operating; and dry electrosensitive paper for handling ease and long storage life.

The options available on the UGR-196C unit being evaluated include: built-in programmer to eliminate echo confusion and data loss; single sweep function for start/stop synchronization with seismic sources; delayed sweep for scale expansion and elimination of the water column; alternate sweep speeds for increased versatility; end-of-paper switch; and elapsed time meter.

B. Progress

The laboratory evaluation is 95% complete on one depth recorder (S/N 102) with only a vibration test remaining. An Instrument Fact Sheet will be written summarizing the laboratory tests.

C. Future Plans

The vibration test is scheduled at the Naval Research Laboratory in January 1975 which will conclude the laboratory tests.

KLEIN ASSOCIATES SIDE SCAN SONAR (MODEL MK-300)

A. Description

The MK-300 Side Scan Sonar System has the capability to chart the ocean bottom with a coverage of 400 meters on both sides of a moving ship for applications such as geology study, search, archeology and cable location. The system consists of a recorder that displays both channels of bottom data and a towfish that contains the transducers and is designed to stay at a given tow depth as the towing speed is increased.

B. Progress

A general test plan for the MK-300 system has been submitted to NAVOCEANO (Code 3551) for review.

C. Future Plans

The evaluation is scheduled to start in July 1975 and be completed in January 1976. Due to budgetary limitations, a field test will not be scheduled for this system in FY/76. An Instrument Fact Sheet will be written summarizing the laboratory tests.

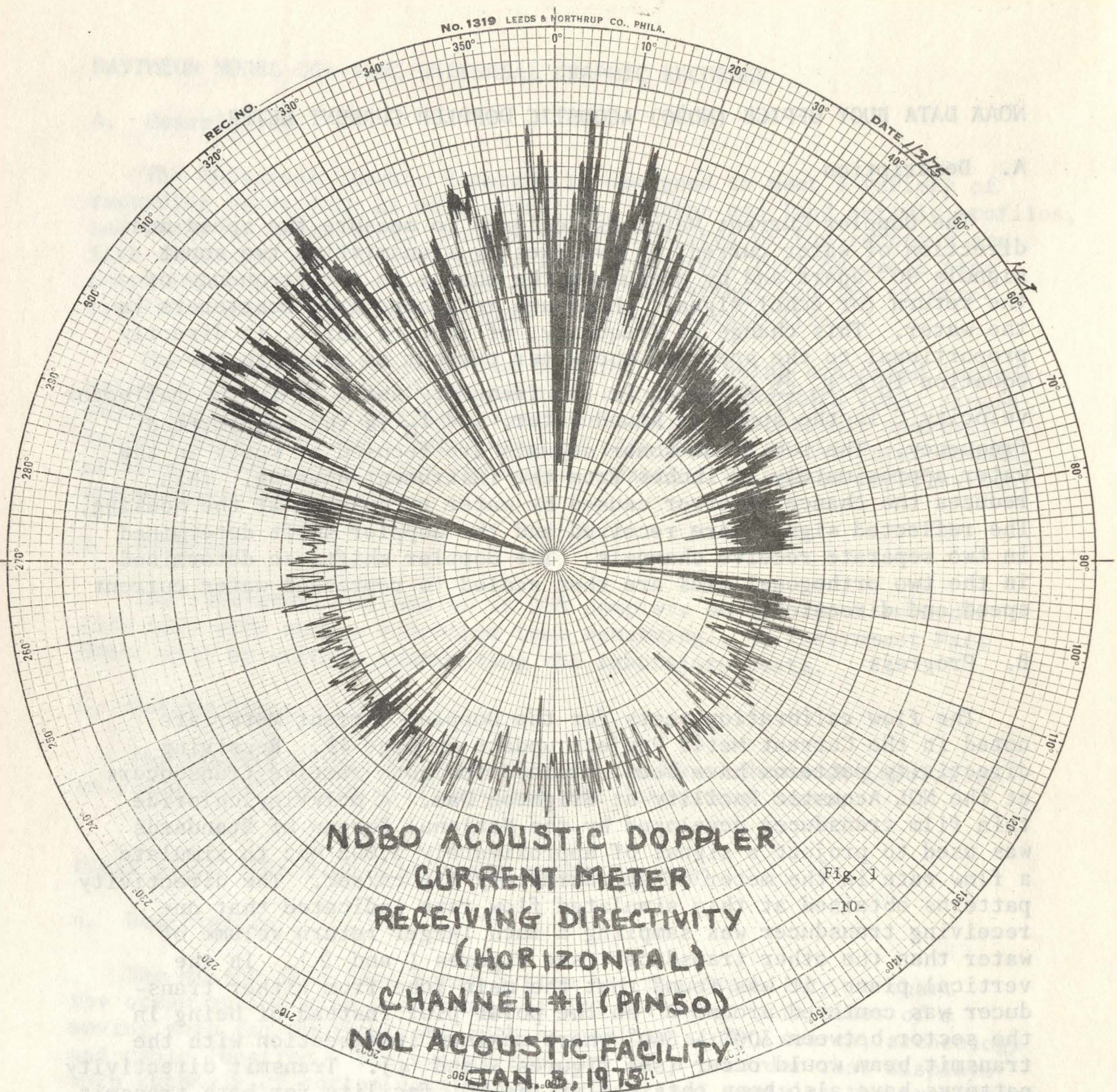
NOAA DATA BUOY OFFICE (NDBO) ACOUSTIC DOPPLER CURRENT METER

A. Description

The Doppler Current Meter is designed to measure the speed and direction of water current in two axes by transmitting two sonar signals 90° apart and by measuring the change in the frequency of the return (or echo) signals which are reflected from scatterers in the water. This change in frequency, of doppler shift, is directly proportional to the speed of the water current as shown in the equation $f_D = f_O \frac{2V}{C}$ where f_D is the frequency shift, V is the reflector velocity, C is the speed of sound water, and f_O is the transmitted frequency. The two 3 Mhz sonar signals are focused at spots in the water approximately 12 inches from the instrument housing. This reduces the chance of error caused by water turbulence at the housing. The reflected signals are received and the doppler shift determined in two separate receive channels. The doppler shifts so determined in the two orthogonal axes are then scaled to represent water current speed and direction.

B. Progress

The flow calibration tests for the Doppler Current Meter are noted in the Current Meter Project update on page 48. Receiving directivity patterns have been obtained for both receive transducers at the NOL Acoustic Facility at Brighton Dam. A polyvinylchloride thin film transducer developed by the National Bureau of Standards was used to project a signal of approximately 3.005 Mhz to simulate a flow rate in the meter of approximately 135 cm/sec. The directivity patterns obtained at this simulated flow rate indicated that one receiving transducer was sampling a much larger return volume of water than the other transducer (see figures 1 and 2). In the vertical plane, it was found that the main lobe from either transducer was centered around 0° on the polar plot instead of being in the sector between 300° - 360° where maximum intersection with the transmit beam would occur (see figures 3 and 4). Transmit directivity patterns have also been obtained at the NOL facility for both transmit transducers using the NBS transducer. The patterns indicate that the acoustic signal from both transducers is coupling into the instrument pressure housing resulting in omnidirectional patterns in both the horizontal and vertical planes. Based on these results, the intersection area of the transmit and receive beams is essentially the same as the receiving directivity pattern determined for each receiving transducer. In this situation, the receiving transducers are sampling a relatively large volume of water which is very close to the instrument housing and this may be a contributing factor to the errors noted in the flow calibration and attributed to signal dropouts.



No. 1319 LEEDS & NORTHRUP CO., PHILA.
REC. NO.
DATE 1/13/75
NDBO ACOUSTIC DOPPLER
CURRENT METER
RECEIVING DIRECTIVITY
(HORIZONTAL)
CHANNEL #1 (PIN 50)
NOL ACOUSTIC FACILITY
JAN. 8, 1975
MADE IN U.S.A.

FIGURE 1.

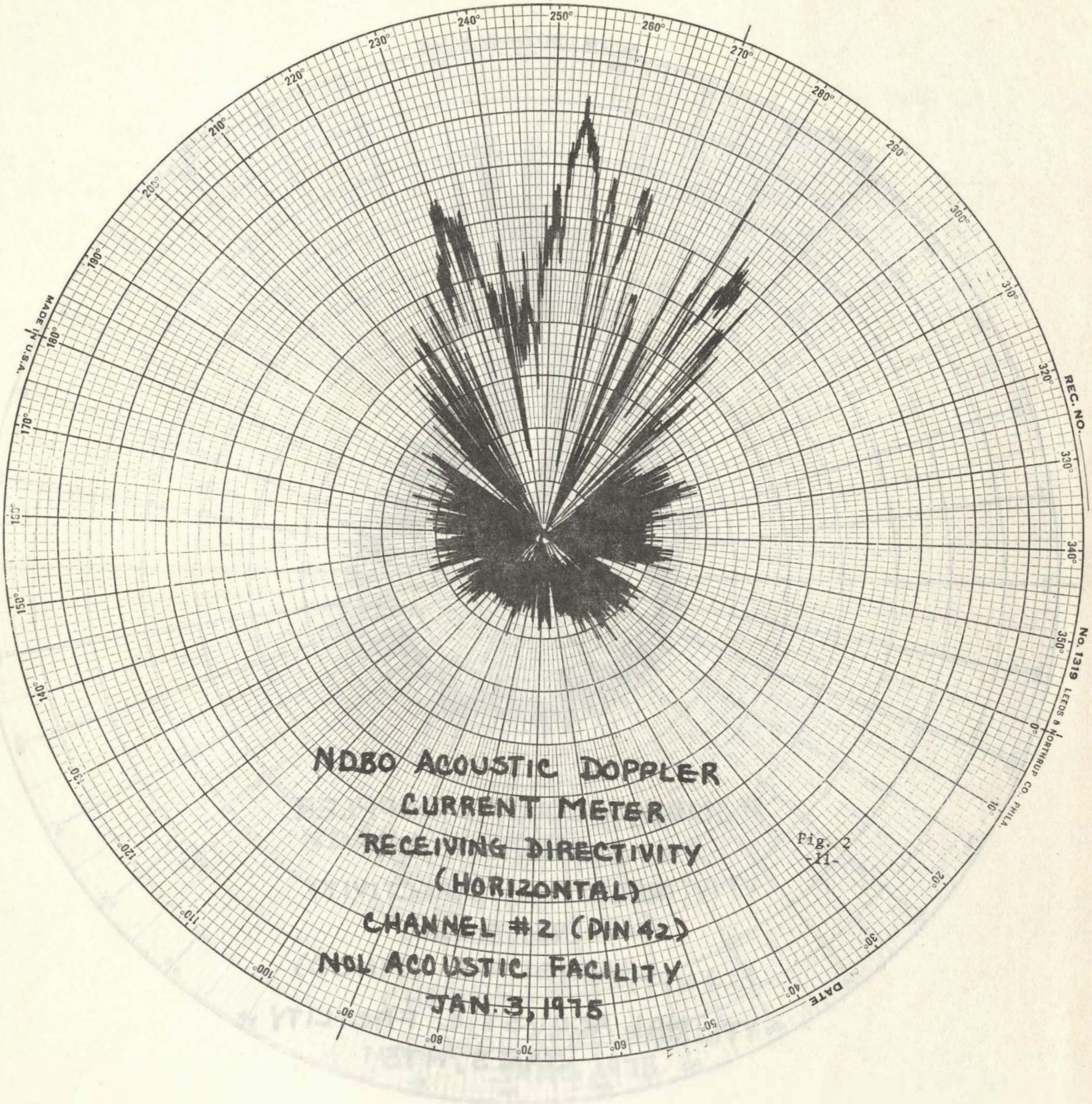

NDBO ACOUSTIC DOPPLER
CURRENT METER
RECEIVING DIRECTIVITY
(HORIZONTAL)
CHANNEL #2 (PIN 42)
NOL ACOUSTIC FACILITY
JAN. 3, 1975
Fig. 2
-11-
REC. NO.
No. 1319
LEEDS & NORTHRUP CO., PHILA.
MADE IN U.S.A.
DATE

FIGURE 2.

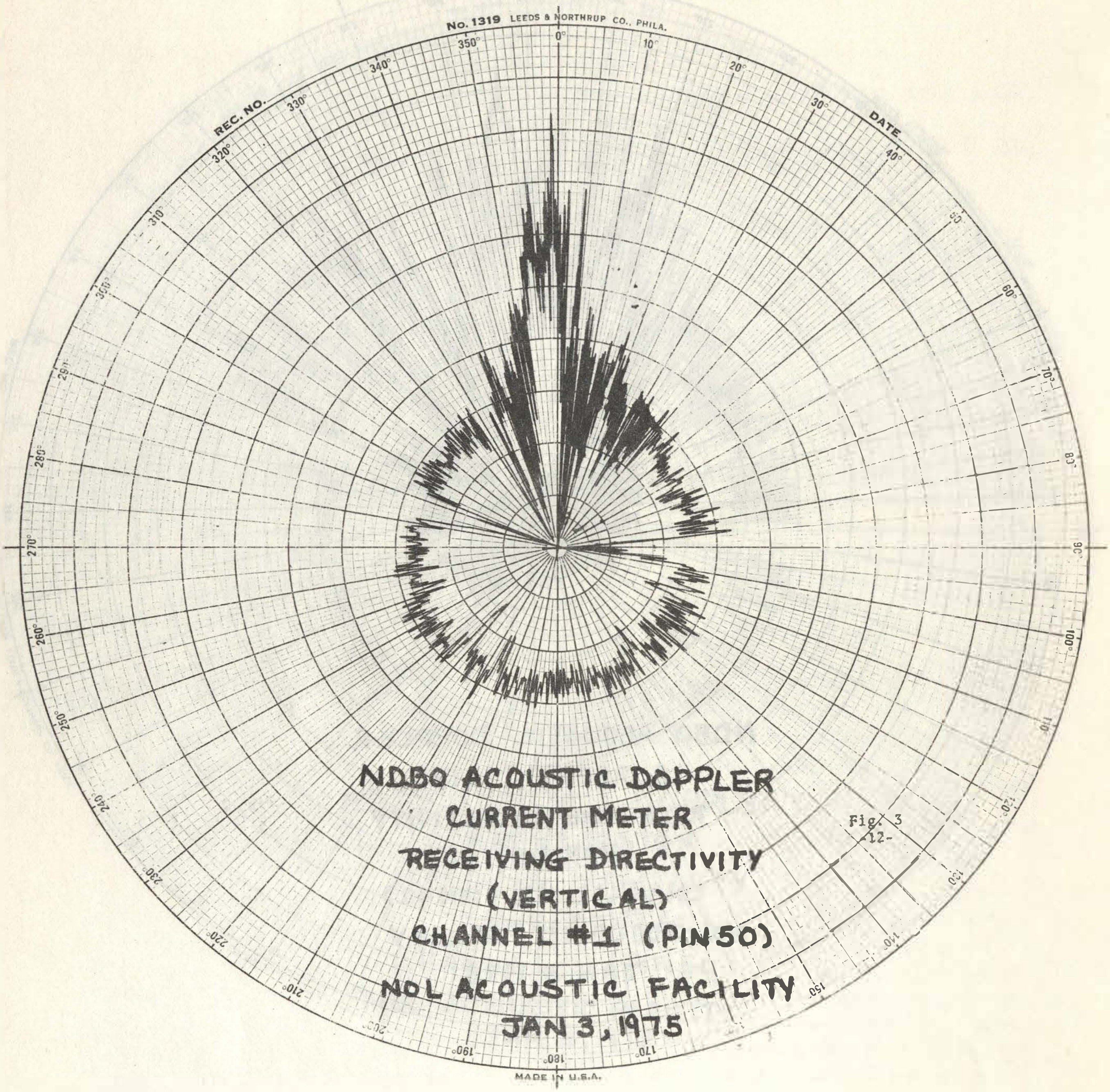

No. 1319 LEEDS & NORTHRUP CO., PHILA.
REC. NO.
DATE
NDBO ACOUSTIC DOPPLER
CURRENT METER
RECEIVING DIRECTIVITY
(VERTICAL)
CHANNEL #1 (PIN 50)
NOL ACOUSTIC FACILITY
JAN 3, 1975
Fig. 3
-12-
MADE IN U.S.A.

FIGURE 3.

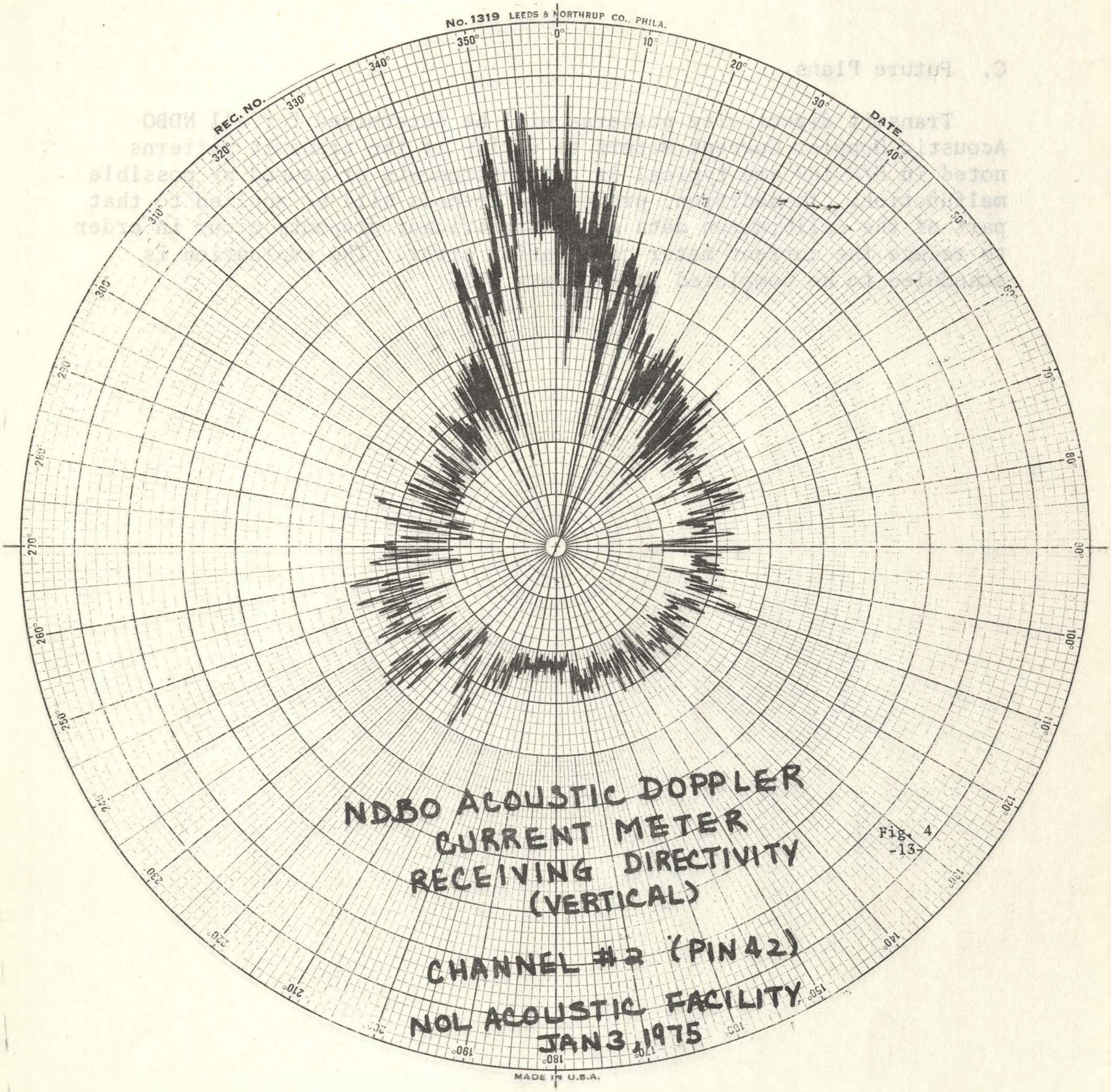


Fig. 4

FIGURE 4.

C. Future Plans

Transmit directivity patterns will be determined for all NDBO Acoustic Doppler Current Meters to verify if the transmit patterns noted in S/N 107 are typical in all instruments or caused by possible malfunction. In addition, processing methods will be applied to that part of the calibration data where significant dropouts occur in order to reduce the current meter calibration error. The evaluation is scheduled to be completed in February 1975.

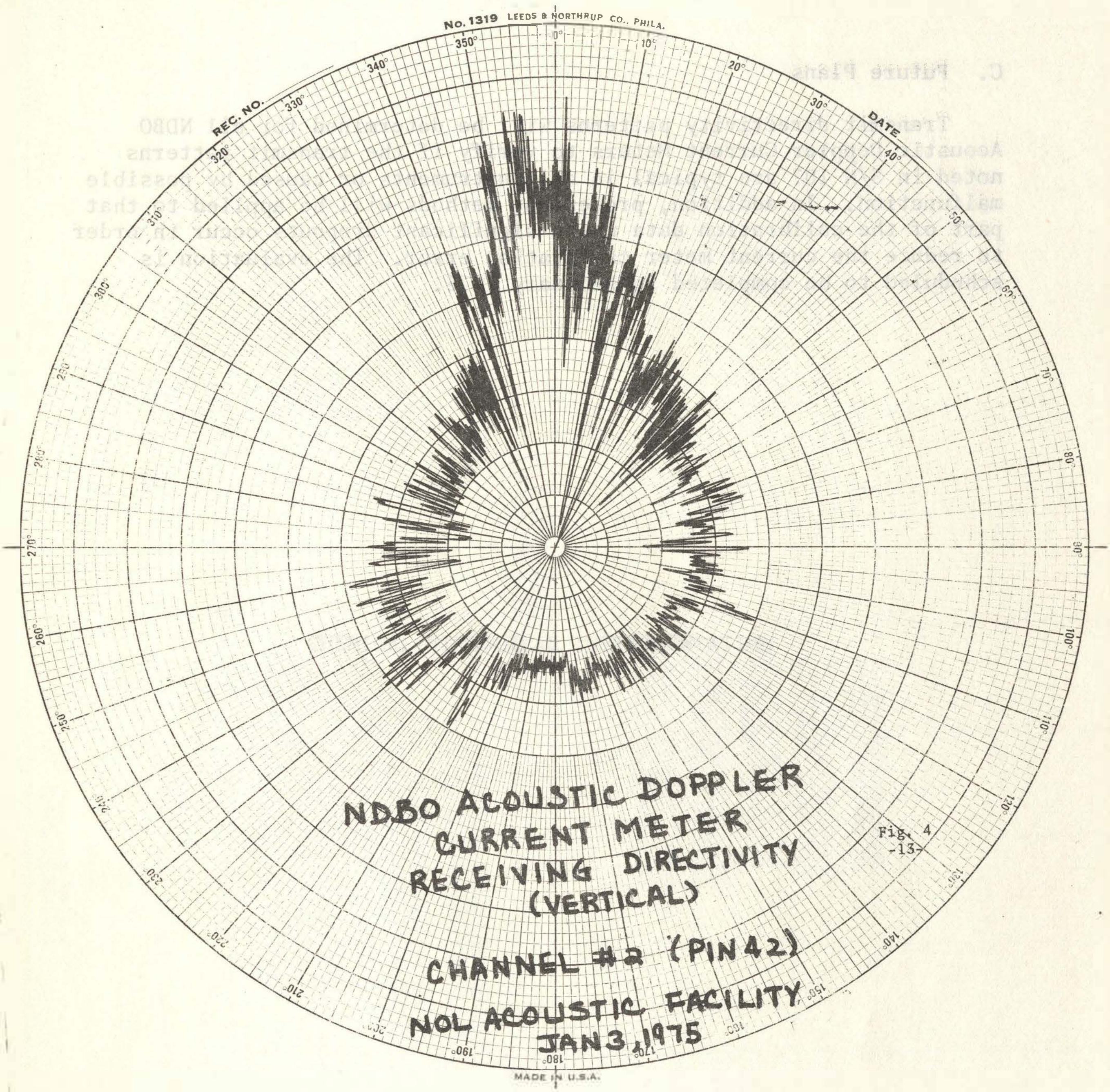


Fig. 4
-13-

FIGURE 4.

C. Future Plans

Transmit directivity patterns will be determined for all NDBO Acoustic Doppler Current Meters to verify if the transmit patterns noted in S/N 107 are typical in all instruments or caused by possible malfunction. In addition, processing methods will be applied to that part of the calibration data where significant dropouts occur in order to reduce the current meter calibration error. The evaluation is scheduled to be completed in February 1975.

CHEMICAL/BIOLOGICAL INSTRUMENTATION

TESTING PROGRAM

Date: January 1, 1975

Project: Chem/Biol.

Project Leader: B. Pijanowski

N — **Navy** **R** — **Reimbursable**
I — **In-House** **O** — **Other**

Task Description	FY'75												FY'76												Req'mt.
	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	
Water Quality Systems																									
Whitney/Montedoro Mark II	X	X	X	X	X	X	X	X																	N
InterOcean Corp. Model 500	X	X	X	X	X	X	X	X																	N
NERA Systems Ekolog 60-1 Mod 4 Water Quality Monitor												X	X	X	X	X	X								N
Dissolved Oxygen Systems																									
Beckman Fieldlab					X	X	X	X	X	X	X														R
Delta Scientific 2010					X	X	X	X	X	X	X														R
Martek DDO						X	X	X	X	X	X														R
Yellow Springs Model 57						X	X	X	X	X	X														R
International Biophysics 170-051						X	X	X	X	X	X														R

WATER QUALITY SYSTEMS - CONTINUING TESTS

A. Description

Four water quality systems previously tested and reported in IFS form are continuing to undergo calibration stability and drift tests. These systems are:

Ocean Data Equipment Corp. WQMS-101A

Leeds and Northrup Water Quality System

HydroLab Corp. Surveyor Model 6D

B. Progress

Dissolved oxygen calibration stability has been tested for a two-month period. Results are presented in figures 5 and 6 . General behavior is summarized in Table 1 and a few general conclusions follow.

1. Most D.O. sensors appear to require a 10 to 12 day conditioning period for freshly recharged sensors. The conditioning treatment consists of soaking the sensor in water with power applied to the unit.
2. Without conditioning, the sensors can be expected to drift between 0.5 and 1 ppm.
3. After conditioning, some sensors may settle down to a drift of less than 0.2 ppm.

C. Future Plans

Similar tests will be carried out on the pH sensors of these systems.

WHITNEY/MONTEDORO CORPORATION MARK II PORTABLE WATER QUALITY MONITORING SYSTEM

A. Description

The system is designed to measure temperature, conductivity, dissolved oxygen, pH and Chloride ion concentration in situ to a depth of 100 meters. Temperature is measured by thermistor, conductivity by an inductive cell, dissolved oxygen by a pressure and temperature compensated polarographic membrane sensor, pH by pressure compensated glass electrodes and Chloride ion by a specific ion electrode. Output for all parameters is digital. Instrument specifications are listed in Table 2 .

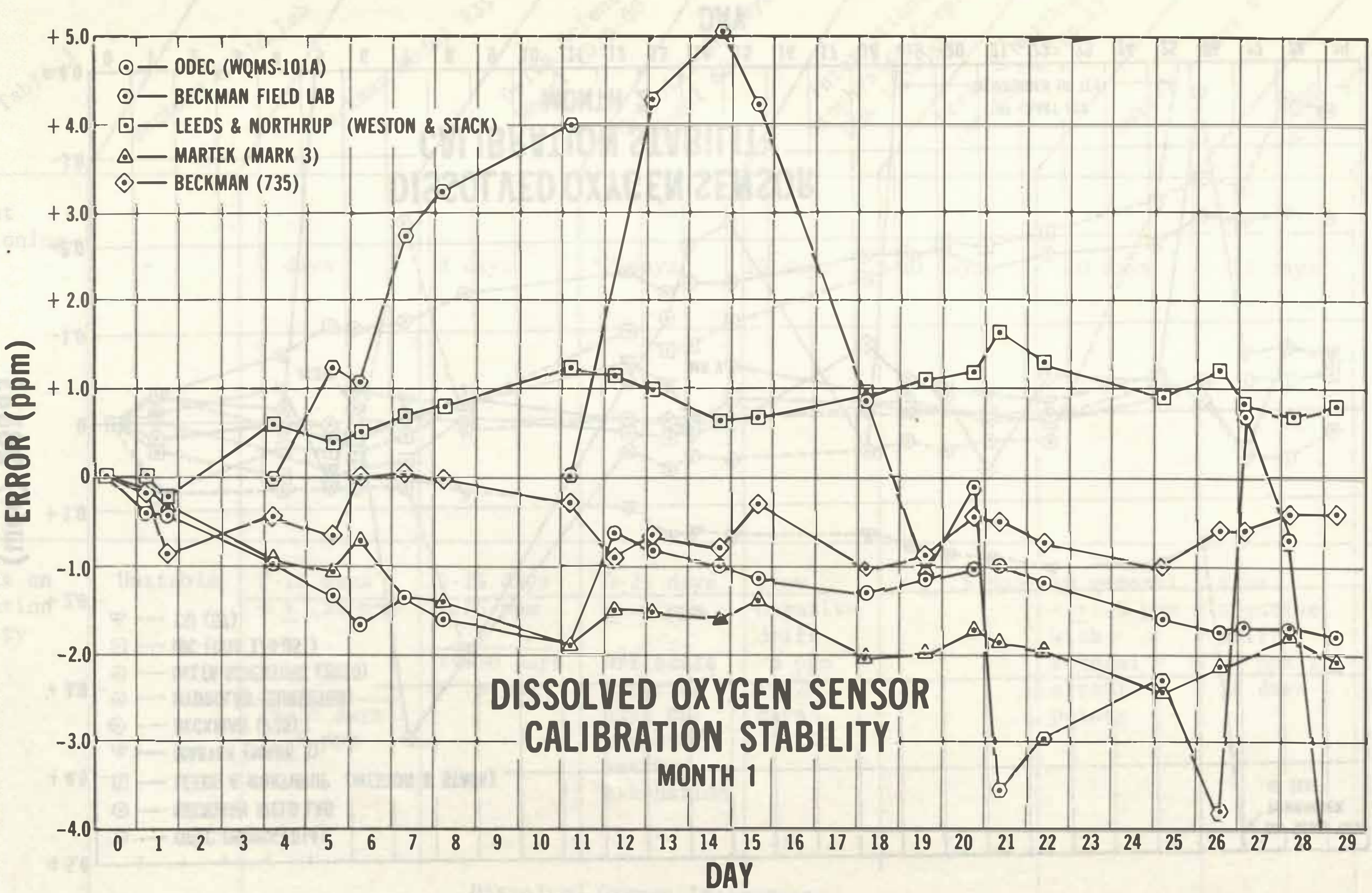

ODEC (WQMS-101A)
BECKMAN FIELD LAB
LEEDS & NORTHRUP (WESTON & STACK)
MARTEK (MARK 3)
BECKMAN (735)
+5.0
+4.0
+3.0
+2.0
+1.0
0
-1.0
-2.0
-3.0
-4.0
ERROR (ppm)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29
DAY
DISSOLVED OXYGEN SENSOR
CALIBRATION STABILITY
MONTH 1

Fig. 5

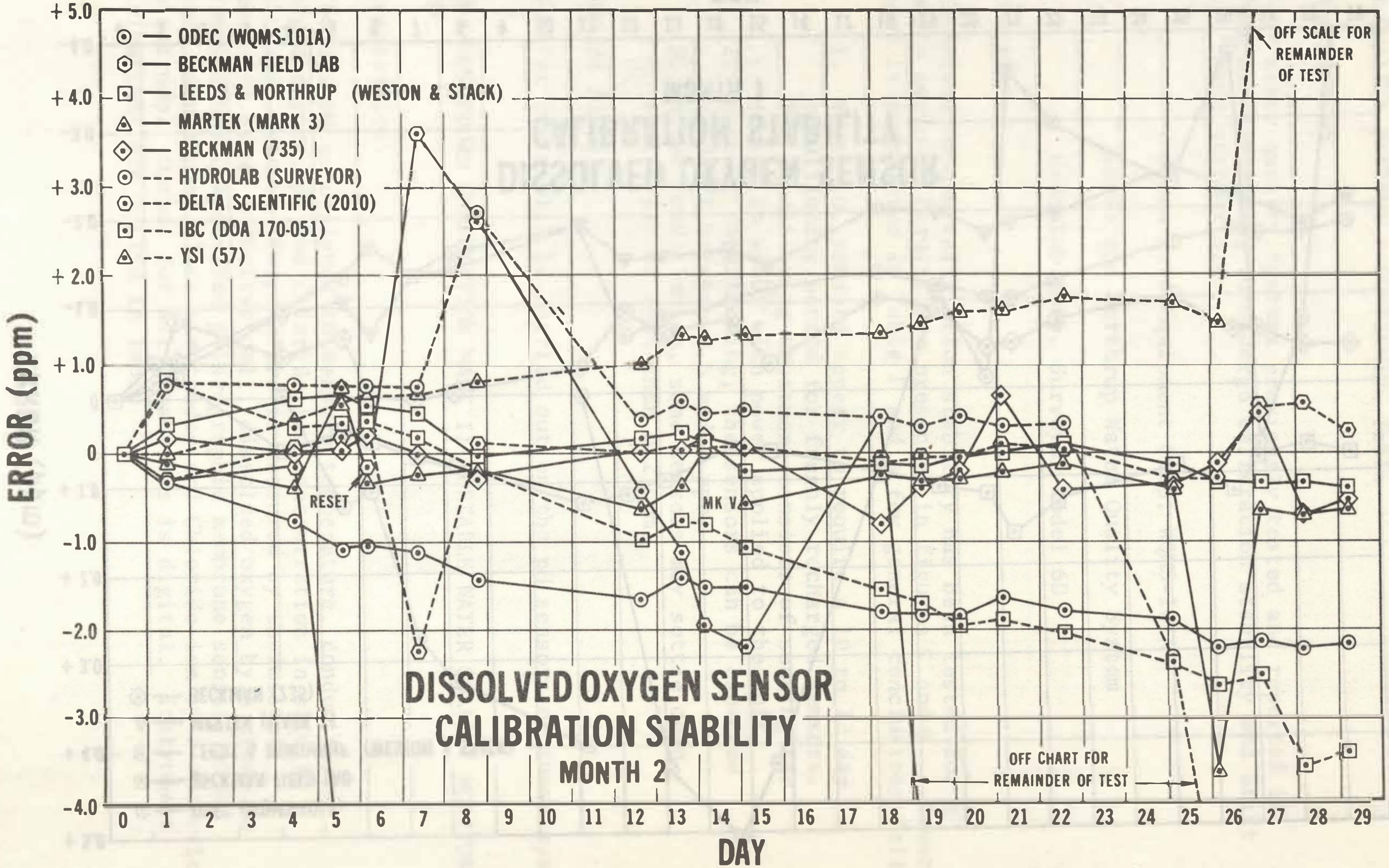

DISSOLVED OXYGEN SENSOR
CALIBRATION STABILITY
MONTH 2
ODEC (WQMS-101A)
BECKMAN FIELD LAB
LEEDS & NORTHRUP (WESTON & STACK)
MARTEK (MARK 3)
BECKMAN (735)
HYDROLAB (SURVEYOR)
DELTA SCIENTIFIC (2010)
IBC (DOA 170-051)
YSI (57)
ERROR (ppm)
DAY
+5.0
+4.0
+3.0
+2.0
+1.0
0
-1.0
-2.0
-3.0
-4.0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29
RESET
MK V
OFF SCALE FOR REMAINDER OF TEST
OFF CHART FOR REMAINDER OF TEST

Fig. 6

Table 1	Beckman Field Lab	Beckman Model 735	Delta Scientific Model 2010-00	HydroLab Surveyor Model 6D	International Biophysics Corp. DOA 170-051	Leeds & Northup Co. (Westen & Stack)	Martek - Mark V	ODEC Model WQMS-101A	YSI Model 57
Apparent Conditioning Period	-	2 days	8 days	12 days	10 days	10 days	10 days	11 days	-
Comments on Calibration Stability	Unstable	0-15 days < ± .25 ppm 15-30 days ± .5 ppm	0-25 days ±.25 ppm 25-30 days + .5 ppm	0-22 days ± .5 ppm off scale after 22 days because of battery exhaustion	slow negative drift -3 ppm in 29 days	< ± .5 ppm	in general < ± .5 ppm with several erratic points	slow negative drift -2 ppm in 28 days	slow positive drift 18 ppm in 28 days large change after 25 days possibly due to battery exhaustion

Dissolved Oxygen Instruments
Long-term Monitoring
Performance Summary

SPECIFICATIONS FOR WATER QUALITY SYSTEMS

TABLE II	INTEROCEAN 513D	WHITNEY-MONTEDORO
Conductivity		
Range	0-65 mmho/cm	0.01 - 100 mmho/cm
	±0.05 mmho/cm	±0.05 mmho/cm
Accuracy	Inductive cell	Inductive cell
Sensor	t.c. - 10ms	(20°C,35°/∘∘ Na Cl)*
Temperature		
Range	-5 to 45°C	0 to 40°C
	±0.05°C	±0.1°C
Accuracy	Thermistor Network	
Sensor	t.c. - 1.4s	Rt - 5s
Depth		
Range	0-100M	0-100M
	±1.M	±0.4M
Accuracy	25% overrange	165 psi max
	tc-50ms	
Sensor	Strain gauge bridge	Solid state *
Dissolved Oxygen		
Range	0-40 ppm	0-20 ppm
	±0.2 ppm	±0.2 ppm
Accuracy	Ag/Pt polarographic (Beckman)	Au/Ag polarographic
Sensor	t.c. - 10s *	Rt - 10s *
pH		
Range	2-14 pH	2-12 pH
	±0.1 pH	±0.05 pH
Accuracy	Combination Ag/AgCl (Beckman)	Combination Ag/AgCl pressure comp.
Sensor	t.c. - 200MS *	Rt - 10S.Max *
Power	External AC or DC +15V -15V	Internal Globe Gel Cells (2) 12V-rechargeable External 12V DC
Environmental Conditions	-5 to 50°C	

*Temperature Compensated

This is an improved version of the system originally tested in January 1973. According to the manufacturer, repairs and extensive modifications have been made.

B. Progress

Conductivity, temperature, and pH testing have been completed on this system although conductivity data have not been completely reduced. Temperature calibration error is shown in figure 7 , and pH error as a function of temperature is shown in figure 8.

During the past six months, it has been necessary to replace the conductivity, temperature, pH and D.O. sensors because of failure. In almost all cases, failure was caused by a breakdown of the temperature compensation electronics. It was also necessary to replace a poorly designed power connector switch and rewire the power supply. The system is designed to be powered by internal DC cells or by external AC or DC. In its original configuration, whenever AC was used, power was routed through the rechargeable DC cells, and the instrument was powered by the cells. Unfortunately, the cells discharged faster than they recharged with a net result of an inoperable system after several hours. Our modification removes the cells from the circuit when not in use.

C. Future Plans

The system will be further evaluated for dissolved oxygen calibration error, depth accuracy and environmental effects on the terminal unit. In addition, a field test is planned for evaluation of the unit under field conditions. Stability and calibration drift of the pH and dissolved oxygen sensors is also planned.

INTEROCEAN MODEL 513D CTD-DOpH SYSTEM

A. Description

The system is designed to measure temperature, conductivity, depth, dissolved oxygen and pH in situ to depths of 100 meters. Temperature is measured by thermistor, conductivity by an inductive cell, dissolved oxygen by a temperature compensated polarographic sensor which is the Beckman Instrument Co. Fieldlab unit and pH is measured by a combination electrode with an Ag/CgCl reference. Output is digital for all parameters. Specifications are listed in Table 2 .

B. Progress

Conductivity, temperature, pressure and pH testing have been carried

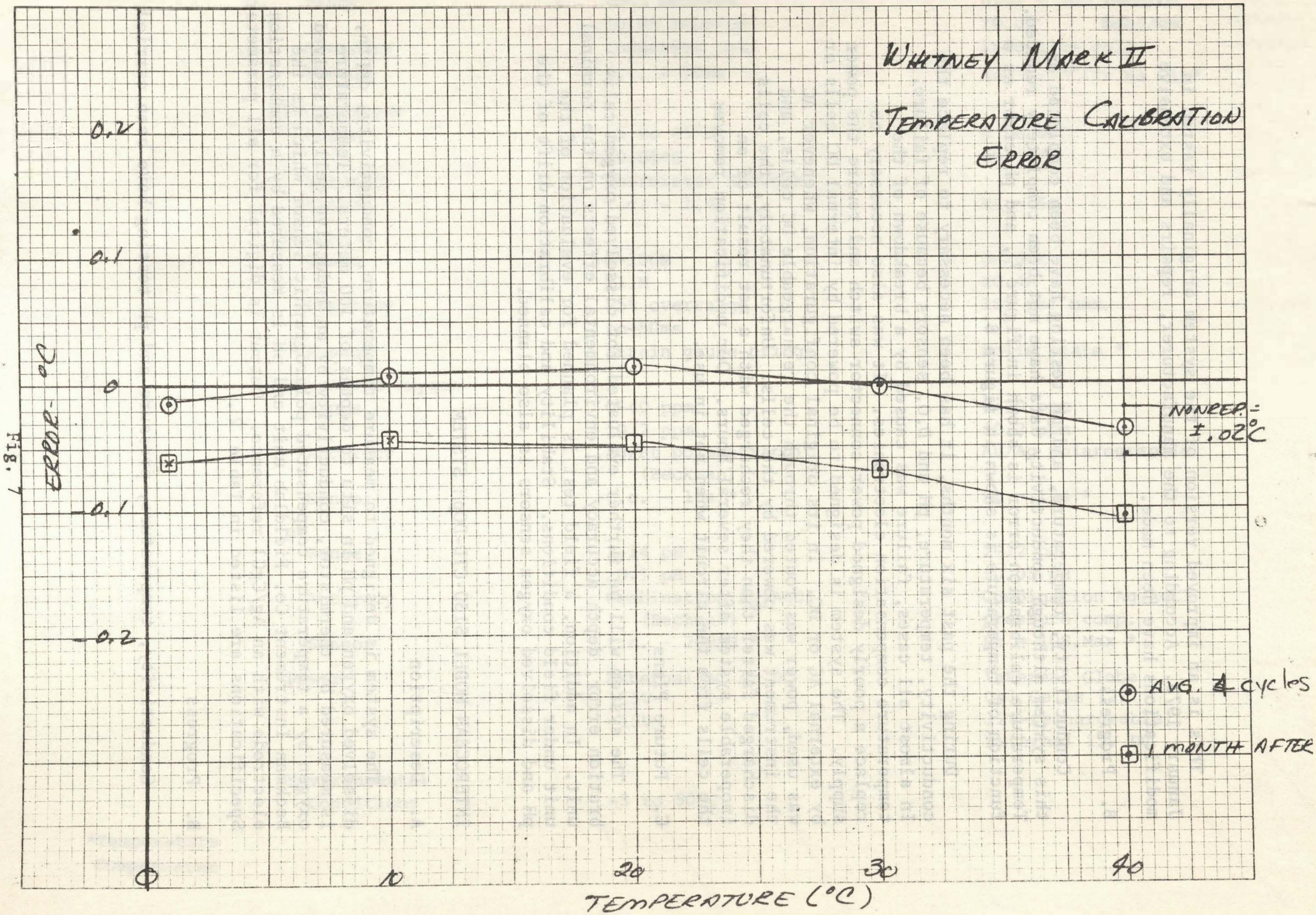

WHITNEY MARK II
TEMPERATURE CALIBRATION ERROR
ERROR - °C
0.2
0.1
0
-0.1
-0.2
0
10
20
30
40
TEMPERATURE (°C)
NONREP. = ±.02°C
AVG. 4 cycles
1 MONTH AFTER

Fig. 7

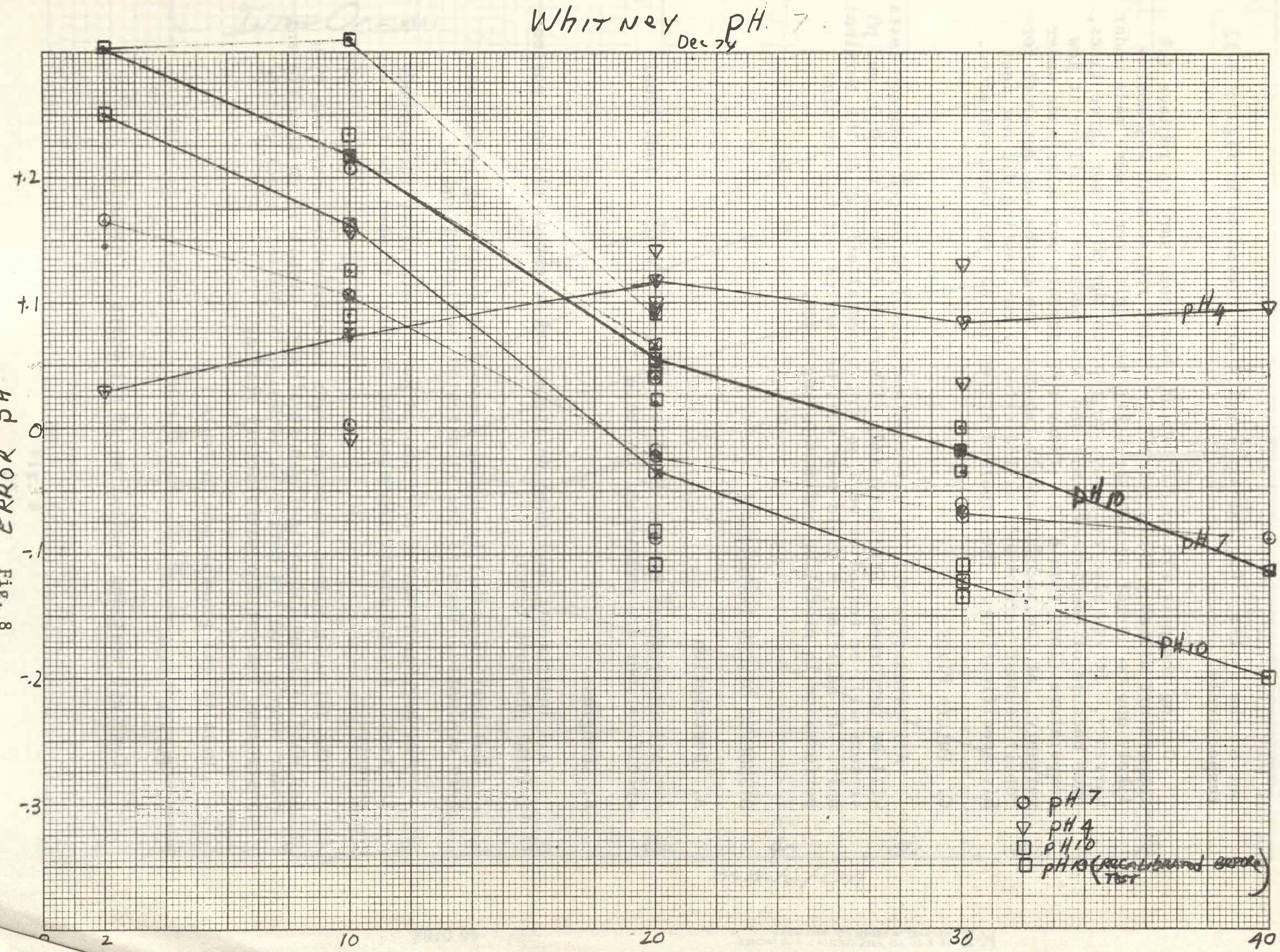

Whitney pH 7
Dec 74
ERROR pH
+.2
+.1
0
-.1
-.2
-.3
2
10
20
30
40
pH 4
pH 10
pH 7
pH 10
pH 7
pH 4
pH 10
pH 10 (RECALIBRATED BEFORE TEST)

Fig. 8

out on the system. Preliminary results are presented in figures 9-12 respectively.

During the past six months, it has been necessary to replace the temperature assembly three times. The first replacement was most likely due to normal aging; the other two replacements were made under warranty. It was also necessary to replace the pH sensor three times, once because of complete failure and twice because of failure at low temperature (less than 6°C). These replacements were also made under warranty. At the manufacturer's request, the system was returned for repair because performance as indicated by our testing did not meet his specifications. The repaired system has not yet been evaluated.

C. Future Plans

All parameters will be retested and dissolved oxygen accuracy tests will be performed. Stability and calibration drift of the D.O. and pH sensors will be tested as well as environmental effects on the terminal unit. In addition, a field test will be carried out to determine performance in profiling and monitoring modes.

DISSOLVED OXYGEN INSTRUMENTS

A. Description

All instruments measure dissolved oxygen in water. Individual specifications are summarized in Table 3.

B. Progress

All instruments have been delivered and accepted; all have passed initial checkout tests.

Calibration stability during a one-month monitoring period has been evaluated. Results are illustrated in figure 1 and 2.

The Beckman Fieldlab unit showed great instability throughout the test. A second unit repeated the instability when the test was repeated.

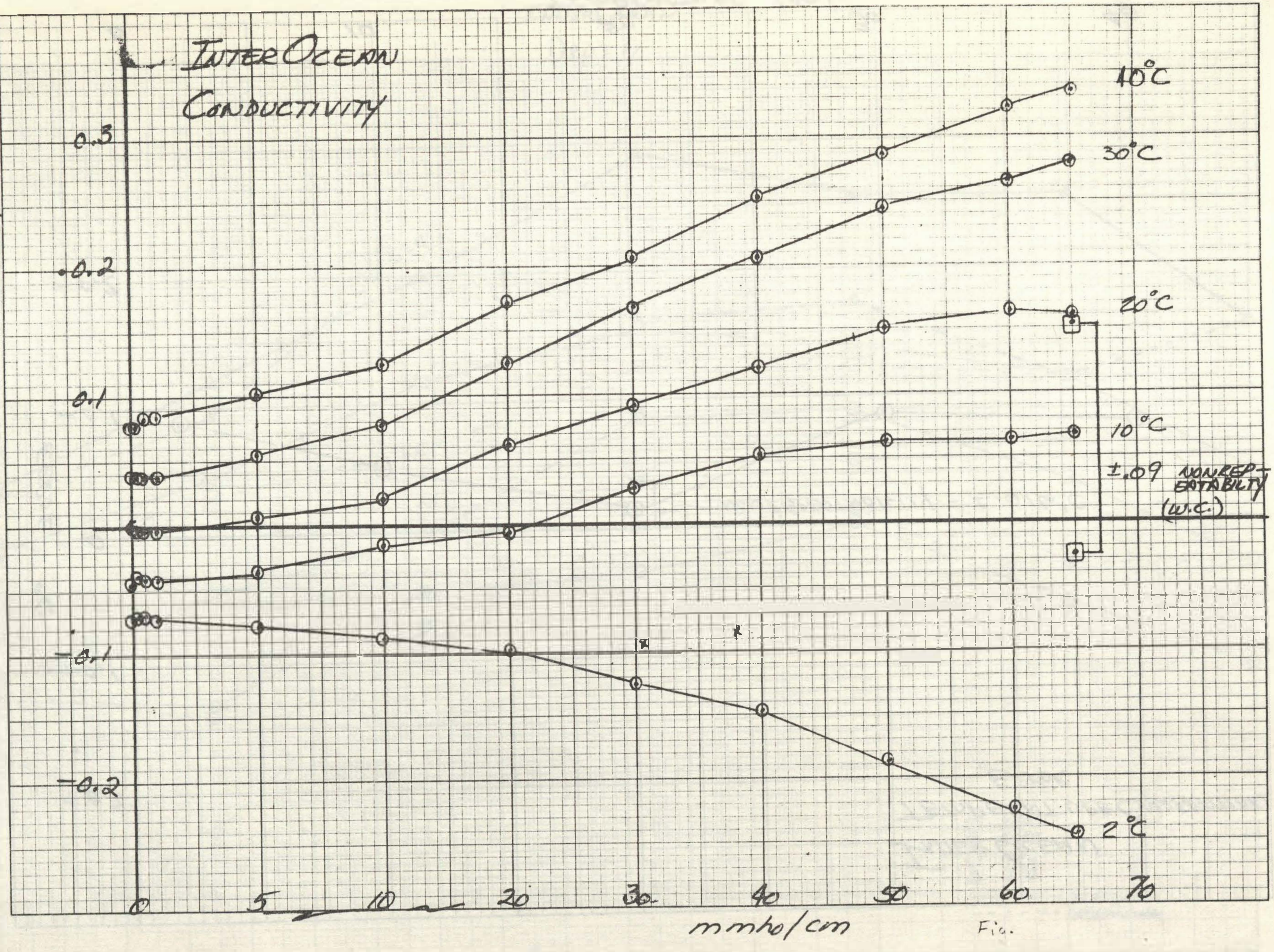
The YSI unit showed a slow updrift in calibration until the 25th day when it jumped drastically-most likely a result of an insufficient power supply from its batteries although the battery check on the instrument indicated a satisfactory reading.

Results are generalized in Table 1 .

C. Future Plans

Complete test and evaluation of all units is planned.

Fig. 9


INTER OCEAN
CONDUCTIVITY
0.3
0.2
0.1
-0.1
-0.2
40°C
30°C
20°C
10°C
2°C
±.09 NONREPEATABILTY
(W.C.)
0
5
10
20
30
40
50
60
70
mmho/cm
Fig.

27

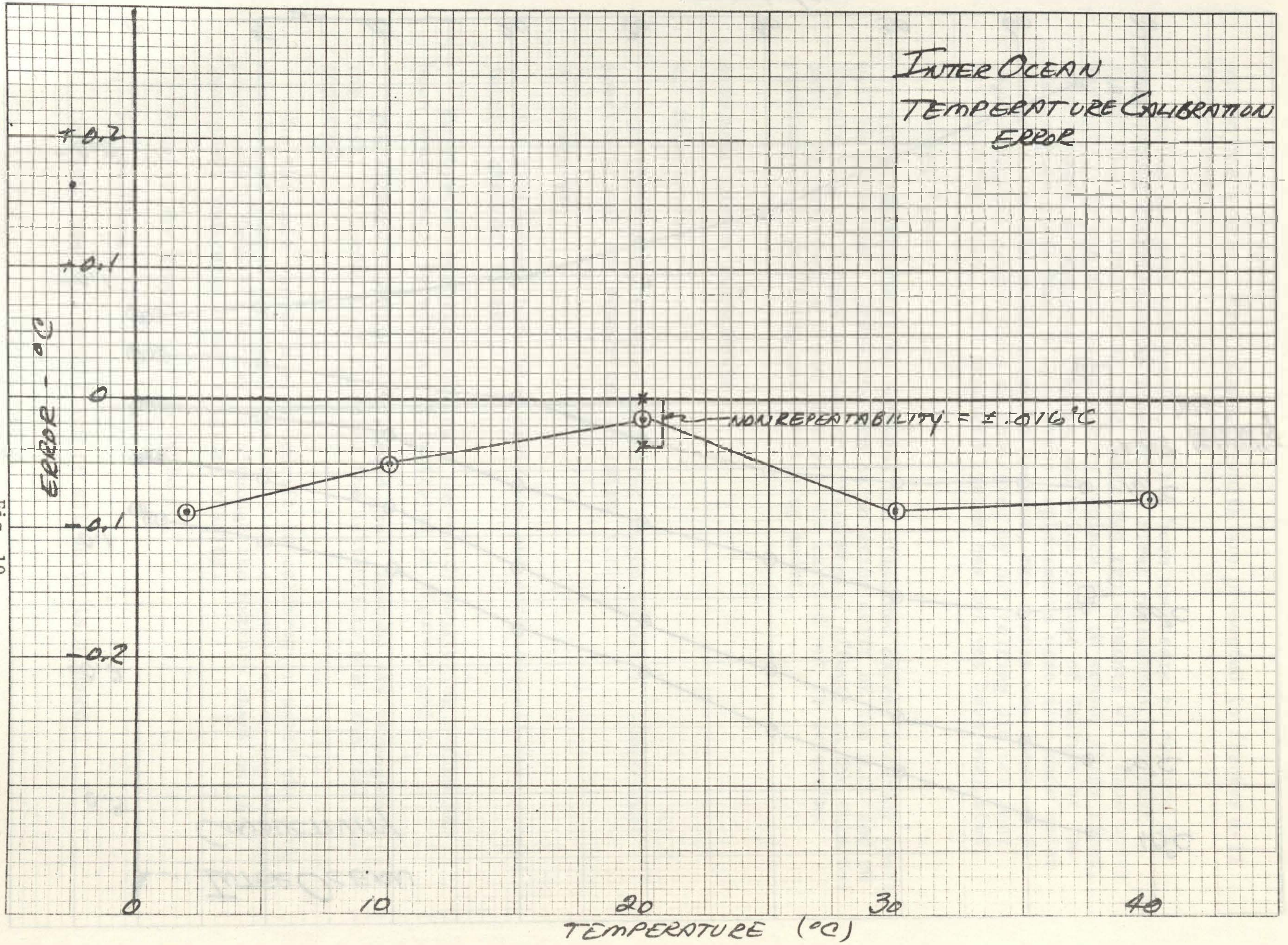

INTER OCEAN
TEMPERATURE CALIBRATION
ERROR
+0.2
+0.1
0
-0.1
-0.2
ERROR - °C
NONREPEATABILITY = ± .0176°C
0
10
20
30
40
TEMPERATURE (°C)

Fig. 10

INNER OCEAN
Depth

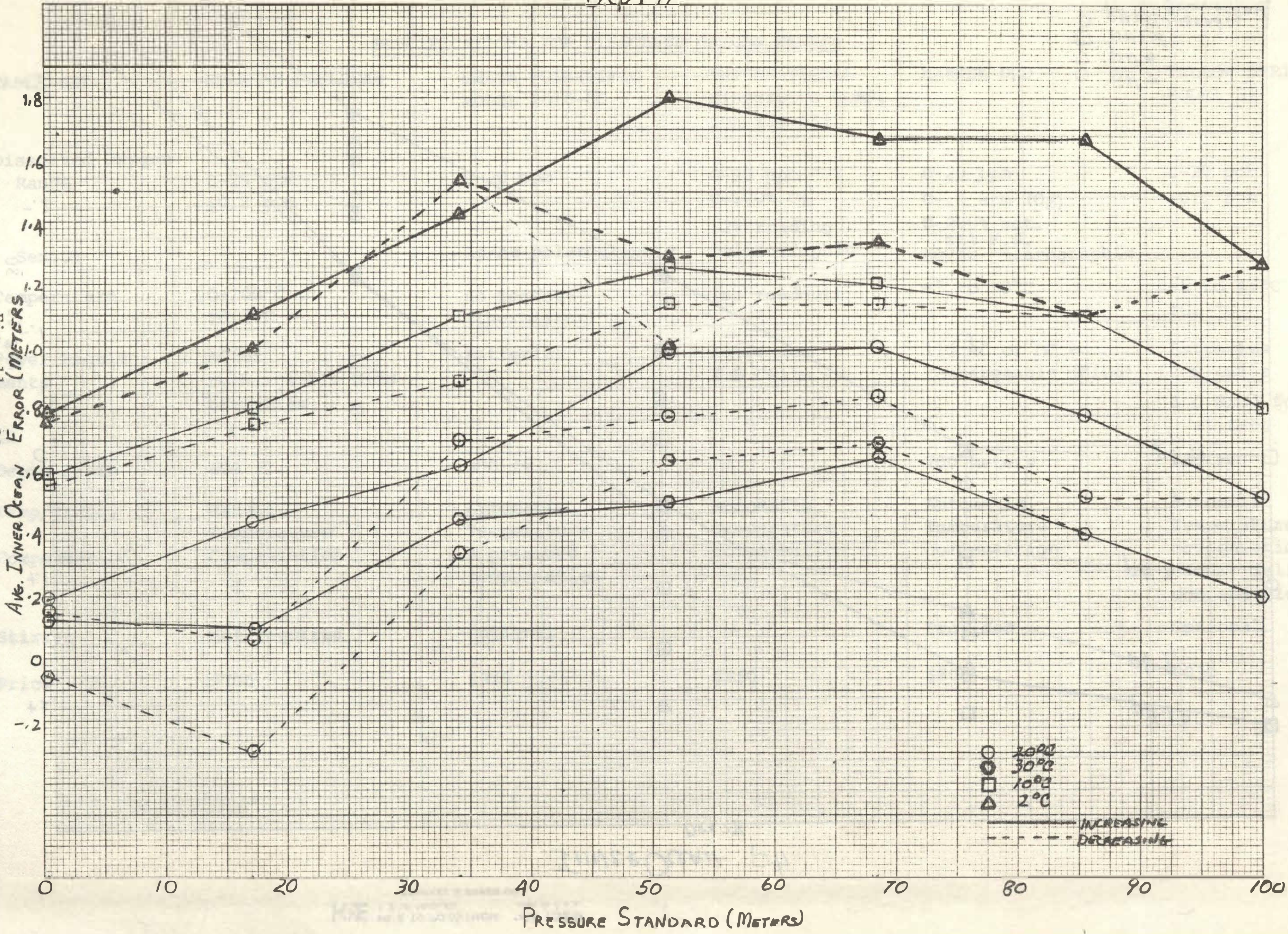


Fig. 11

INNER OCEAN pH

Dec 74

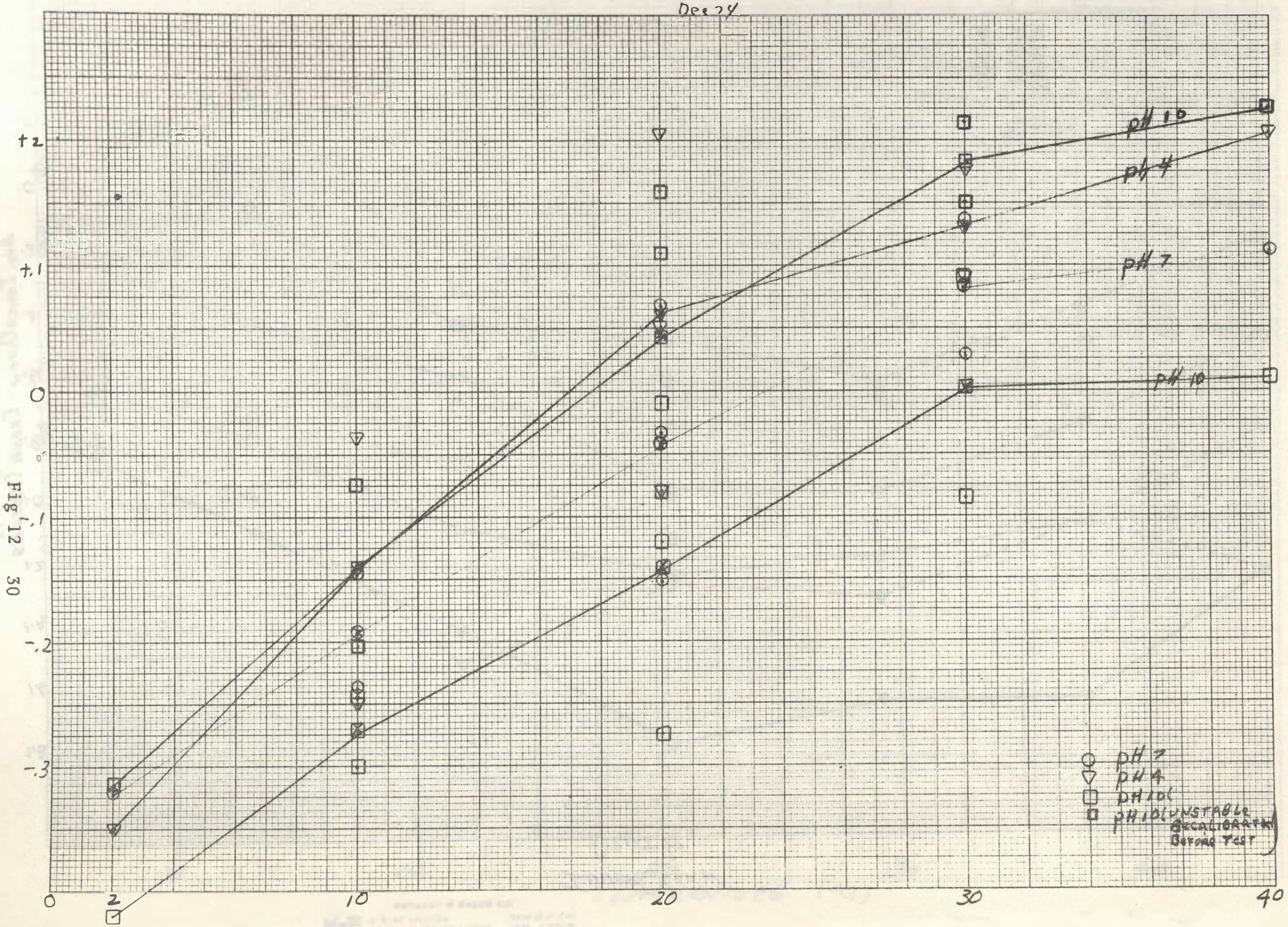


Fig 12 30

SPECIFICATIONS FOR DISSOLVED OXYGEN METERS

TABLE III	BECKMAN FIELDLAB	DELTA SCIENTIFIC MODEL 2010-00	INTERNATIONAL BIOPHYSICS CORP. DOA 170-051	MARTEK DDO	YELLOW SPRINGS MODEL 57
Dissolved Oxygen Range	0-25 ppm ±0.2 ppm	0-20 ppm	0-20 ppm 0-100% O_2 ±2% reading	0-20 ppm 0-.4 atm (O_2) 0-200% sat. ±1% F.S.	0-20 ppm ±0.1 ppm
Sensor		Ag/Au polarographic	polarographic	Ag/Au polarographic	
Temperature	0-100°C ±0.1°C	no readout (thermistor)	(no readout)	-5 to 50°C	-5 to 45°C ±0.7°C
Power Requirements	AC or rechargeable NiCd batteries	Batteries	Batteries 4 D Cells	115 AC or DC - rechargeable (NiCd)	Batteries 2 C cells 5 C NiCd for stirrer
Depth Limit	600 ft.	300 ft.		200 meters	250 ft.
Temp/Press. Compensation	Manual Temperature Compensation	Automatic Temperature & pressure compensation	Automatic Temperature compensation	Automatic Temperature compensation	Automatic Temperature compensation Manual Salinity compensation
Stirrer	Not required	Optional		Provided	Optional
Price	\$700	\$925	\$450	\$800	\$850

CONDUCTIVITY/SALINITY-TEMPERATURE-DEPTH MEASURING SYSTEMS (C/STDs)

TESTING PROGRAM

Date: January 1, 1975

Project: C/STD

Project Leader: J. Boyd

N — Navy R — Reimbursable
I — In-House O — Other

Task Description	FY'75 J	A	S	O	N	D	J	F	M	A	M	J	FY'76 J	A	S	O	N	D	J	F	M	A	M	J	Req'mt.
NuSonics Model 3200-3004-170 CTD/SV System	■	■	■	■	■	■	■																		I
NDBO-NDBP-EEP Ocean Sensor (CTD Portion)	■	■	■	■	■	■	■																		R
Plessey Model 9090 XSTD System										■	■	■	■												N, I
Plessey UOR (ODAS)											■	■													R
Balsbaugh Conductivity Sensor																									R
Guildline MKIV CTD System												■	■	■	■	■	■								N
Guildline Model 8400 Laboratory Salinometer							■	■	■	■	■														N, I

NUSONICS MODEL 3200-3004-170 CONDUCTIVITY-TEMPERATURE-DEPTH-SOUND VELOCITY SYSTEM

A. Description

The NuSonics Model 3200-3004-170 CTD-SV System is designed to measure, telemeter, and condition ocean variables of seawater conductivity, temperature, depth (pressure), and sound speed. The system consists of an underwater unit (NuSonics Model 1641-169) and shipboard signal converter. Two separate pressure housings make up the underwater unit with each containing transducers (sensors) and conditioning electronics for transmission of data to the shipboard signal converter for each of the variables being measured. Temperature is sensed with a platinum wire resistance thermometer, conductivity with an inductively coupled toroidal cell, pressure with a resistance strain gauge bridge, and sound speed with acoustic transducers employed in a sing-around sound path. The sensed variables are converted to FM data signals, frequency multiplexed, and transmitted to the signal converter by a single electrical conductor. DC power is transmitted to the underwater unit via another conductor, thus the electrical sea cable requiring two separate electrical conductors with the armor carrying the signal and power returns.

The shipboard signal converter provides the following functions and are listed below in the approximate sequence of their occurrence:

1. The FM multiplexed sensor signal is amplified.
2. The FM multiplexed sensor signal is separated into four separate data signals (frequency).
3. Each frequency is amplified.
4. Each frequency is converted from sinewave to squarewave and multiplied to a condition that is compatible with its respective Scaled D-A converter.
5. Each frequency is converted to a 0-10 VDC analog signal which is available over a wide sensor measurement range or narrow overlapping ranges depending on a switch setting.

B. Progress

Approximately, an additional 45% of the planned laboratory performance evaluation tests were completed on this system bringing the total to 95% for completion of all tests. The completed tests for this reporting period included performance tests on the pressure and sound velocity measurement channels, performance tests on the shipboard signal converter, and inherent noise measurements of the underwater and shipboard signal converter units.

Preliminary test results for the four sensing channels of the underwater unit are given below:

NuSonics CTD-SV System
Preliminary Test Results

Conductivity Channel (mho x 10^{-3}/cm)

a.	Nonrepeatability (@ 10°C using wire loop method)	±0.004
b.	Nonlinearity (@ 10°C)	±0.028
c.	Temperature Effect	0.01% of reading per C°
d.	Systematic Calibration Errors*	-0.343 → 0.242
e.	Long-term Stability	+0.137

Temperature Channel (°C)

a.	Nonrepeatability	±0.010
b.	Nonlinearity (includes temperature effects)	±0.003
c.	Systematic Calibration Errors*	0.021 → 0.098
d.	Long-term Stability (5 mos.)	-0.011°C

Pressure Channel (Meters)

a.	Nonrepeatability	±0.39
b.	Hysteresis	1.37
c.	Nonlinearity (@ 10°C)	±1.04
d.	Temperature Effect	0.00092% of reading per C°
e.	Systematic Calibration Errors*	0.65 → 3.35 @ 10°C

Sound Velocity Channel∇ (M/sec)

a. Nonrepeatability	±0.33
b. Nonlinearity	±0.18
c. Systematic Calibration Errors*	-0.48 → 0.04

Table 4 is a summary of the sensor noise measurements.

C. Future Plans

Complete the planned laboratory test and evaluation of the CTD-SV System. The remainder of the work includes analysis of test data collected during performance and noise measurements on the shipboard signal converter, and long-term stability tests on the pressure and sound velocity sensing channels. A summary of all tests will be written and published in an Instrument Fact Sheet. The total evaluation effort should be completed by mid-February 1975.

WESTINGHOUSE ELECTRIC CORPORATION/NOAA DATA BUOY OFFICE OCEAN SENSOR

A. Description

The Westinghouse Electric Corporation (WEC) Ocean Sensor (OS) was developed for the NOAA Data Buoy Office's Engineering Experimental Phase. The OS is mounted on a data buoy hull or to a mooring line at various depths. The OS consists of a pressure housing, electronics, and transducers. The sensor, after interrogation from a Sensor Deck Unit (SDU) converts oceanographic environmental measurements into telemetering signals that are transmitted through the SDU to an Ocean Platform System. The OS contains the electronics and transducers required to obtain measurements for conductivity, temperature and pressure.

B. Progress

Approximately, an additional 30% of the planned laboratory evaluation tests were completed on this system bringing the total to 100% for completion of all tests. The completed tests for this reporting period included a rerun of performance tests on the conductivity measurement channel and performance tests on the pressure measurement channel. Prior to the rerun of the performance tests on the conductivity sensor, the same type of failure occurred in the conductivity transducer as reported earlier where the cell liner cracked. This time the liner had multiple cracks; in fact, it crumpled when removed as opposed to a longitudinal hairline crack which occurred in the previous failure.

*Referenced to manufacturer's supplied calibration equation.
∇All tests performed in salt water with a salinity of about 35 ppt and temperatures ranging from 0 → 30°C.

Table IV

Summary of Sensor Noise Measurements

Sensor Channel	Measurand Value	Period us	Noise ns	Noise[1] Meas. Units	Un-[2] certainty
Temperature	3°C	814.0400	± 41.6	± 1.2 m°C	±0.3 m°C
Conductivity	40 mmho/cm	226.3602	± 14.6	±11.7 umho/cm	±0.7 umho/cm
Sound Speed	1461 m/s	93.9994	± 3.4	±54.4 mM/S	±4.6 mM/s
Pressure	0 psig	4001.1842	±124.7	±67.3 mM	±6.5 mM

[1]Peak-to-peak noise determined from thirty 1,000 period average measurements on a HP5245L Electronic Counter.

[2]Estimated error in noise measurement due to both random variations in the average period measurements (trigger error of the electronic counter) and bath temperature.

An Automatic Data Collection System was used to collect and store all test data during the test and evaluation of the Ocean Sensor. Data were recorded on punch paper tape recorder in a code and format convenient for computer processing. Figure 13, 14, and 15 show computer printout results of a calibration test performed on the OS's temperature, conductivity, pressure measurement channel, respectively.

C. Future Plans

Process the remainder of the Ocean Sensor test data. Write and publish a final test and evaluation report in the form of a NOAA Technical Memorandum. This effort should be completed by March, 1975.

PLESSEY MODEL 9090 EXPENDABLE SALINITY-TEMPERATURE-DEPTH SYSTEM (XSTD)

A. Description

The Model 9090 XSTD System is designed to obtain economical Temperature and Salinity or Sound Velocity profiles from the ocean environment. The system consists of inexpensive expendable probes that measure conductivity and temperature and simultaneously transmit this data over a wire link to shipboard processing equipment that provides real time output functions of conductivity, temperature, and cast duration for digital binary magnetic recording. The processor also provides computed salinity or sound velocity and temperature as a function of depth for analog graphic recording.

The probe is designed for operation to depths of 750 meters over temperature and salinity ranges of -2 → 35°C and 30 → 40 ppt. It can be deployed from existing, hand-held, deck-mounted, or through-hull launchers, since it is mechanically interchangeable with the Expendable Bathythermograph (XBT).

In addition to the processor, the shipboard equipment also includes an analog multipen recorder and an incremental, digital magnetic tape cassette recorder. Information stored on tape is processed through a tape processor which can be purchased as peripheral equipment with the XSTD System. The company also offers a tape processing service by mail.

B. Progress

A field operational test plan was prepared in November, 1974. Requests were made for ship time aboard a NOAA vessel for this effort.

C. Future Plans

Perform 4 1/2 months of laboratory and field performance evaluations on the XSTD System beginning March, 1975. As presently envisioned, field

Figure 13

RESULTS OF CALIBRATION FOR WATER TEMPERATURE SENSOR SERIAL NUMBER 23

NT	INDEPENDENT VARIABLE (X1)	STANDARD VALUE (YS)	FITTED VALUE (YF)	RESIDUAL (YF-YS)	CONFIDENCE LIMITS (+/-)	
026	.40046E+04	.399798E+02	.39987E+02	.73E-02	.14E-01	531
027	.32050E+04	.319833E+02	.31994E+020	.11E-01	.13E-01	31
028	.24050E+04	.239985E+02	.23997E+02	-.12E-020	.13E-01	30
029	.16070E+040	.160168E+020	.16020E+02	.35E-02	.13E-01	31
030	.80700E+030	.802632E+010	.80232E+01	-.31E-020	.14E-01	30
031	.10000E+020	.540812E-010	.56138E-010	.21E-02	.14E-01	30
032	.80700E+030	.802495E+010	.80232E+01	-.17E-020	.14E-01	30
033	.16060E+040	.160097E+020	.16010E+02	.56E-03	.13E-01	30
034	.24050E+04	.239946E+020	.23997E+02	.27E-02	.13E-01	30
035	.32040E+040	.319833E+020	.31984E+02	.11E-02	.13E-01	30
036	.40050E+040	.399785E+02	.39991E+020	.13E-01	.14E-01	31
002	.40024E+040	.399714E+02	.39965E+02	-.60E-020	.14E-01	431
003	.32033E+040	.319797E+020	.31977E+02	-.26E-02	.13E-01	430
004	.24040E+040	.239896E+020	.23987E+02	-.23E-02	.13E-01	30
005	.16050E+040	.160024E+020	.16000E+02	-.21E-02	.13E-01	30
006	.80700E+030	.801780E+010	.80232E+01	.54E-020	.14E-01	31
007	.32000E+010	.325806E-01	.38145E-010	.56E-020	.14E-01	430
008	.80600E+030	.801636E+01	.80132E+01	-.32E-02	.14E-01	30
009	.16040E+040	.160037E+020	.15990E+02	-.13E-01	.13E-01	33
010	.24036E+040	.239928E+020	.23983E+02	-.95E-02	.13E-01	431
011	.32030E+040	.319823E+020	.31974E+02	-.79E-02	.13E-01	31
012	.40030E+040	.399758E+020	.39971E+02	-.44E-02	.14E-01	30
014	.40040E+040	.399838E+02	.39981E+02	-.24E-02	.14E-01	30
015	.32040E+040	.319897E+020	.31994E+02	-.53E-02	.13E-01	31
016	.24050E+040	.239976E+020	.23997E+02	-.28E-03	.13E-01	30
017	.16060E+040	.160181E+020	.16010E+02	-.78E-020	.13E-01	31
018	.80700E+030	.802665E+010	.80232E+01	-.34E-020	.14E-01	30
019	.10000E+020	.413464E-010	.56138E-01	.15E-01	.14E-01	33
020	.80700E+030	.802270E+010	.80232E+01	.50E-03	.14E-01	30
021	.16060E+040	.160152E+020	.16010E+02	-.49E-02	.13E-01	31
022	.24050E+040	.239955E+02	.23997E+020	.18E-02	.13E-01	30
023	.32050E+040	.319901E+020	.31994E+020	.43E-02	.13E-01	31
024	.40050E+040	.399835E+02	.39991E+020	.79E-02	.14E-01	31

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Figure 14

RESULTS OF CALIBRATION FOR
WATER CONDUCTIVITY SENSOR
SERIAL NUMBER 23

NT	INDEPENDENT VARIABLE (X1)	STANDARD VALUE (YS)	FITTED VALUE (YF)	RESIDUAL (YF-YS)	CONFIDENCE LIMITS (+/-)	
072	.59500E+02	.1168452E+021	.16662E+02	-.18E+00	.30E+00	511
073	.26300E+03	.1198182E+021	.19669E+02	-.15E+00	.30E+00	11
074	.94273E+031	.297291E+021	.29714E+02	-.15E-01	.30E+00	910
075	.116213E+041	.1396411E+021	.39742E+02	.10E+00	.30E+00	411
076	.123000E+041	.495543E+021	.49771E+02	.22E+00	.30E+00	11
077	.29794E+041	.594681E+02	.59811E+02	.34E+00	.30E+00	413
078	.140950E+041	.763256E+02	.76297E+02	-.28E-01	.31E+00	10
079	.129796E+041	.1594681E+021	.59814E+02	.35E+00	.30E+00	513
080	.123000E+041	.495543E+021	.49771E+02	.22E+00	.30E+00	11
081	.116213E+041	.1396411E+021	.39742E+02	.10E+00	.30E+00	411
082	.194323E+031	.1297291E+021	.29722E+02	-.76E-02	.30E+00	810
083	.26300E+031	.198182E+021	.19669E+02	-.15E+00	.30E+00	11
084	.159667E+021	.1168452E+021	.16665E+02	-.18E+00	.30E+00	411
016	.160233E+021	.168452E+02	.16819E+02	-.27E-01	.30E+00	410
017	.126135E+031	.198182E+02	.19791E+02	-.28E-01	.30E+00	410
018	.192972E+031	.297291E+02	.129668E+02	-.61E-011	.29E+00	511
019	.15980E+04	.1396411E+021	.139543E+02	-.98E-011	.29E+00	11
020	.122660E+041	.1495543E+021	.49415E+02	-.14E+00	.29E+00	11
021	.129360E+041	.1594681E+021	.59316E+02	-.15E+00	.30E+00	11
022	.140710E+041	.763256E+02	.76088E+02	-.24E+00	.31E+00	11
023	.129360E+041	.1594681E+021	.59316E+02	-.15E+00	.30E+00	11
024	.122666E+041	.1495543E+021	.49424E+02	-.13E+00	.29E+00	411
025	.115985E+041	.1396411E+021	.39551E+02	-.90E-01	.29E+00	511
026	.193000E+03	.297291E+021	.29672E+02	-.57E-01	.29E+00	10
027	.126137E+03	.198182E+021	.19791E+02	-.27E-01	.30E+00	410
028	.60267E+021	.168452E+02	.16819E+02	-.26E-01	.30E+00	410
002	.161000E+021	.1168452E+021	.116976E+021	.13E+00	.30E+00	11
003	.126200E+031	.1198182E+021	.19946E+021	.13E+00	.30E+00	11
004	.92979E+03	.1297291E+021	.29815E+021	.86E-01	.30E+00	410
005	.15980E+04	.1396411E+021	.139690E+021	.49E-01	.30E+00	110
006	.122655E+041	.1495543E+021	.149559E+02	-.10E-021	.30E+00	510
007	.129345E+041	.1594681E+021	.159439E+02	-.29E-011	.30E+00	510
008	.140695E+041	.763256E+02	.176212E+02	-.11E+001	.31E+00	510
009	.129343E+041	.594681E+02	.159437E+02	-.31E-011	.30E+00	410
010	.22656E+04	.1495543E+021	.49555E+02	.47E-03	.30E+00	410
011	.15980E+04	.1396411E+021	.39683E+02	.48E-01	.30E+00	10
012	.92976E+03	.297291E+02	.129814E+021	.185E-01	.30E+00	410
013	.126200E+031	.198182E+021	.19946E+021	.13E+001	.30E+00	11
014	.161107E+021	.168452E+02	.16978E+021	.113E+00	.30E+00	311

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Figure 15

RESULTS OF CALIBRATION FOR
WATER PRESSURE SENSOR
SERIAL NUMBER 23

NT	INDEPENDENT VARIABLE (X1)	STANDARD VALUE (YS)	FITTED VALUE (YF)	RESIDUAL (YF-YS)	CONFIDENCE LIMITS (+/-)	
072	.12000E+02	.000000E+00	.27001E+01	.27E+01	.69E+01	41
073	.91793E+02	.973469E+02	.10047E+03	.31E+01	.68E+01	641
074	.17000E+03	.193907E+03	.19630E+03	.24E+01	.67E+01	41
075	.25200E+03	.293304E+03	.29678E+03	.35E+01	.67E+01	41
076	.32960E+03	.389890E+03	.39186E+03	.20E+01	.68E+01	440
077	.41140E+03	.489293E+03	.49209E+03	.28E+01	.68E+01	941
078	.45000E+03	.538278E+03	.53939E+03	.11E+01	.69E+01	40
079	.41127E+03	.489293E+03	.49193E+03	.26E+01	.68E+01	941
080	.32860E+03	.389890E+03	.39063E+03	.74E+00	.68E+01	640
081	.25100E+03	.293304E+03	.29555E+03	.22E+01	.67E+01	941
082	.16860E+03	.193907E+03	.19458E+03	.68E+00	.67E+01	640
083	.90179E+02	.973255E+02	.98493E+02	.12E+01	.69E+01	640
084	.12000E+02	.000000E+00	.27001E+01	.27E+01	.69E+01	41
016	.10000E+01	.000000E+00	-.40308E+01	-.40E+01	.68E+01	41
017	.88000E+02	.973255E+02	.92769E+02	-.46E+01	.67E+01	41
018	.16800E+03	.195285E+03	.19079E+03	-.45E+01	.66E+01	41
019	.24810E+03	.293304E+03	.28895E+03	-.44E+01	.66E+01	441
020	.32800E+03	.391268E+03	.38684E+03	-.44E+01	.66E+01	41
021	.40800E+03	.489293E+03	.48487E+03	-.44E+01	.67E+01	41
022	.44800E+03	.538278E+03	.53388E+03	-.44E+01	.68E+01	41
023	.40800E+03	.489293E+03	.48487E+03	-.44E+01	.67E+01	41
0241	.32800E+03	.391268E+03	.38684E+03	-.44E+01	.66E+01	41
0251	.24800E+03	.293304E+03	.28882E+03	-.45E+01	.66E+01	41
0261	.16800E+03	.195285E+03	.19079E+03	-.45E+01	.66E+01	41
0271	.88000E+02	.973255E+02	.92769E+02	-.46E+01	.67E+01	41
028	.10333E+02	.000000E+00	.23971E+01	.24E+01	.68E+01	841
002	.15793E+02	.000000E+00	.12352E+01	.12E+01	.69E+01	440
003	.96000E+02	.973233E+02	.99514E+02	.22E+01	.68E+01	40
004	.17600E+03	.195281E+03	.19754E+03	.23E+01	.67E+01	41
005	.25600E+03	.293298E+03	.29556E+03	.23E+01	.67E+01	41
006	.33600E+03	.391259E+03	.39359E+03	.23E+01	.68E+01	41
007	.41600E+03	.489282E+03	.49161E+03	.23E+01	.68E+01	40
008	.45600E+03	.538266E+03	.54063E+03	.24E+01	.69E+01	40
009	.41600E+03	.489282E+03	.49161E+03	.23E+01	.68E+01	40
010	.33600E+03	.391259E+03	.39359E+03	.23E+01	.68E+01	41
011	.25600E+03	.293298E+03	.29556E+03	.23E+01	.67E+01	41
012	.17600E+03	.195281E+03	.19754E+03	.23E+01	.67E+01	41
013	.96000E+02	.973233E+02	.99514E+02	.22E+01	.68E+01	40
014	.15897E+02	.000000E+00	.13620E+01	.14E+01	.69E+01	440

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tests will be performed from the NOAA ship, MT. MITCHELL, in June during a transit from Norfolk, Virginia, to the New York Bight region.

Write and publish a final test and evaluation report in the form of a NOAA Technical Memorandum.

PLESSEY UNDULATING OCEANOGRAPHIC RECORDER'S OCEANOGRAPHIC DATA ACQUISITION SYSTEM

A. Description

The Oceanographic Data Acquisition System (ODAS) was designed specifically to measure and record environmental parameters while mounted in a vehicle being towed behind a ship at a fixed depth (8 → 100 meters) or undulating in a triangular pattern within the same depth interval. It is completely self-contained with sensors, measuring and control electronics, a reel-to-reel incremental digital tape record for data storage, and two separate rechargeable NiCad battery pack assemblies for system power. Presently, it is equipped with three sensors (capable of handling up to eight sensors), a temperature, conductivity and pressure sensor. Temperature is sensed with a thermistor, conductivity with a five electrode cell, and pressure with a strain-gauge bridge. System specifications are ±0.1°C, ±0.1°/₀₀, and ±5 meters for the temperature, salinity (conductivity), and depth (pressure) measurements, respectively. Each sensor measurand signal is converted to a 10 bit binary number and recorded on the digital tape recorder. Sampling is switch selectable from 2 per minute to 30 per hour with a recording duration capability of 6 to 24 hours, respectively.

B. Progress

No performance evaluation testing was performed on ODAS for this reporting period. The unit was undergoing repair and design modifications at the Engineering Development Laboratory (EDL), Office of Marine Technology, National Ocean Survey, NOAA.

C. Future Plans

It will be recommended to EDL that NOIC perform six weeks of laboratory performance and environmental tests on ODAS prior to beginning phase II UOR sea trials, tentatively scheduled for mid-September, 1975. If acceptable, laboratory tests should begin in May or June, 1975. After completion of tests, an ODAS laboratory test and evaluation report will be written for submission to EDL.

GUILDLINE MODEL 8700, MARK IV DIGITIZED OCEANOGRAPHIC DATA COLLECTION SYSTEM

A. Description

The system is designed to provide in-situ digital measurements of conductivity, temperature, and pressure (depth) utilizing pulse amplitude techniques of data transmission over a possible length of 6,000 meters of single conductor cable.

The basic Mark IV System consists of an underwater probe and shipboard deck unit. The underwater unit consists of a lightweight aluminum pressure case which internally contains the associated electronics for the sensors, digitizer, multiplexer and data transmission circuits. A block diagram of this circuitry is shown in Figure 16.

The CTD sensors are located in a cage which is mounted on the pressure case.

Data obtained by the underwater unit is derived simultaneously for all three parameters which is then stored and transmitted sequentially to the surface by bi-polar pulses.

The associated shipboard unit circuits process the information to produce 16 bit binary readings and decodes these to decimal with illuminated displays for each parameter.

The underwater probe is designed for ease of field maintenance without disturbance of calibrated accuracy. Modular construction is used throughout each circuit function and is finished in the form of interchangeable plug-in circuit boards and sensors which can be independently calibrated. The conductivity cell is an electrode type which is known to have much reduced proximity or "area" effect associated with induction type cells.

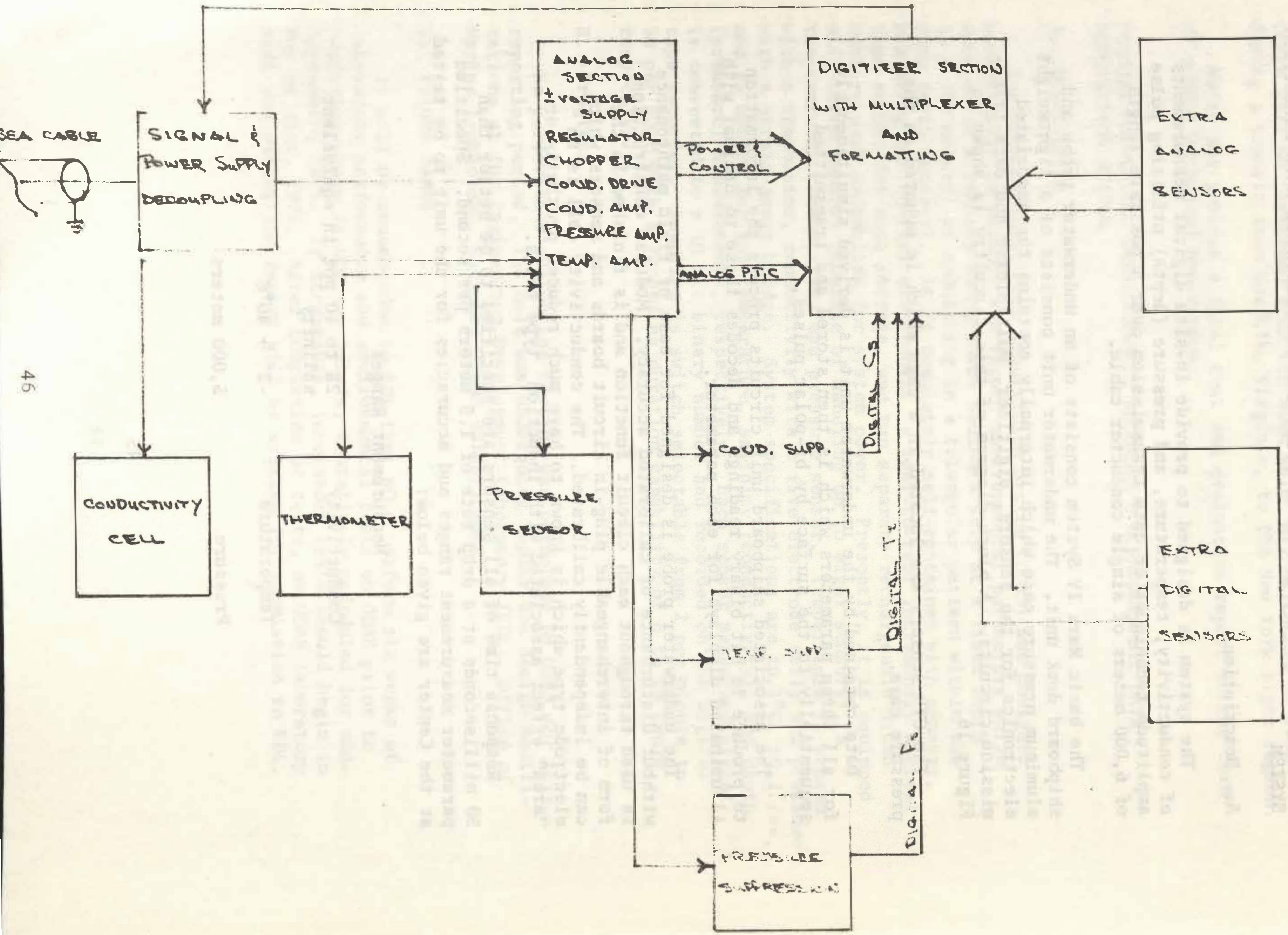
Response time of all sensors are specified to be better than 50 milliseconds at a drop rate of 1.5 meters per second. Specified parameter measurement ranges and accuracies for the unit to be tested at the Center are given below:

Measurement Ranges

Conductivity	28 to 40 ppt in equivalent salinity
Temperature	-2° → 40°C
Pressure	5,000 meters

Figure 16

DIGITAL CTD PROBE BLOCK DIAGRAM



	Accuracies
Conductivity	±0.01 ppt in equivalent salinity
Temperature	±0.01°C
Pressure	±0.15% FS

B. Progress

Procurement action was initiated by the Naval Oceanographic Office for two Model 8700, Mark IV Systems. One of the systems will be sent to NOIC for laboratory performance and environmental tests.

A minimal effort has been spent on a logic circuit design that will directly interface the parameter data (16 bit binary words) to the NOIC Data Collection System. This will easily allow collection and computer processing of all test data as was performed on the WEC Ocean Sensor.

C. Future Plans

Develop and write a detailed performance and environmental test plan.

Perform six months of performance and environmental tests on the System beginning about June 1975.

GUILDLINE LABORATORY SALINOMETER MODEL 8400

A. Description

This instrument is designed for laboratory use which measures and displays the conductivity ratio of an unknown water sample with respect to standard Copenhagen water. A square wave potential comparator technique is used to continuously compare the resistance of a cell filled with a sample salinity solution at constant known temperature with an integral reference resistor initially adjusted to the cell resistance when filled with standard water at the same temperature. A four electrode conductivity cell is used to sense the conductance. Readout is both digital display and BCD output.

B. Progress

An improved version of the system has been provided by the manufacturer. Calibration stability records have been kept, however, little testing has been accomplished.

Two minor components failed and were replaced by the manufacturer: a drive belt on the bath stirrer broke and a specially molded rubber stopper at the sample intake broke from frequent flexing.

C. Future Plans

Develop and write a detailed performance and environmental test plan.

Develop a temperature measuring system that will provide continuous readout of Autosal bath temperature on an analog strip-chart recorder with an eye reading resolution of <0.0002°C. It is presently envisioned to use the digital output from a Woods Hole Oceanographic Institution developed temperature transfer standard to drive a digital to analog converter with its output driving the recorder. This system should provide a recording resolution where one minor division equals 0.0002°C; absolute temperature can be read from the WHOI's decimal display unit with an inaccuracy of <±0.005°C.

Perform four months of laboratory tests beginning March, 1975.

CURRENT MEASURING INSTRUMENTATION

TESTING PROGRAM

Date: January 1, 1975

Project: Current Meters

Project Leader: G. Appell

N — Navy **R** — Reimbursable
I — In-House **O** — Other

Task Description	FY'75 J	A	S	O	N	D	J	F	M	A	M	J	FY'76 J	A	S	O	N	D	J	F	M	A	M	J	Req'mt.
Electromagnetic																									
MMI Model 750									■	■	■	■													N
NDBO-EG&G CT-3			■	■	■	■	■	■																	R
NDBO-EG&G ILOS																									R
NDBO-WEC EMCM-OS						■	■	■	■																R
NUC EMCM							■			■	■	■	■												N
Acoustic																									
NDBO-EDO Doppler						■	■	■																	R
Rotor - Impeller																									
NAVOCEANO MKIII													■	■	■	■	■								N
ENDECO Type 110																■	■	■	■	■					N
Other																									
Dynamic Tests																									N,I
Cerc-ducted Meters																									R
Niskin "Integrating"																									N
MODS - USCG	■	■																							I,O

MARSH-MCBIRNEY INC. (MMI) MODEL 750 ELECTROMAGNETIC CURRENT METER

A. Description

This meter is solid state, no moving parts instrument designed to measure two orthogonal vector components of water current velocity simultaneously in a plane perpendicular to the transducer.

This model is similar to the previously tested Model 711 but represents the latest attempt at improving the directivity of cylindrical shaped probes. Electrodes are mounted in raised ridges that run the length of the probe. The theory is to project the electrodes outside of the boundary layer to minimize the effect of disturbances.

B. Progress

No new progress during this reporting period. As related in the last report, test results indicate the directivity is considerably worse than anticipated with error up to 20 per cent. The raised ridges apparently created a hydrodynamic problem that makes directivity response patterns a function of velocity. Directivity and x-channel calibration tests were completed and all other tests were cancelled because of the poor instrument performance.

C. Future Plans

Test results were conveyed to the manufacturer who has promised a transducer redesign and replacement. The program will be restarted upon receipt of the new transducer.

EG&G MODEL CT/3 ELECTROMAGNETIC CURRENT METER

A. Description

The NOAA Data Buoy Office (NDBO) has provided two CT/3 current measuring systems to NOIC for a limited performance evaluation.

The EG&G - CT/3 is a self-orienting single axis electromagnetic current meter. The meter is enclosed in a prolate spheroid (torpedo-shaped), finned housing which secures to a bottom anchored buoy mooring and which aligns with current direction. An internal flux-gate compass senses magnetic North.

Current velocity magnitude is measured by a pair of "uni-probe" transducers which combine both electrode and excitation coil in a single unit. The current meter provides a record of elapsed time, water temperature and current speed and direction on digital magnetic tape cassette.

B. Progress

Steady flow velocity tests have been completed at the NSRDC tow facility and magnetic flux-gate compass tests performed at Hyde Field airport. Data analysis has been performed and performance charts prepared. Figures 17 through 21 are error plots for the direction and speed tests.

C. Future Plans

Dynamic heave simulation tests will be performed at NSRDC.

WESTINGHOUSE/NDBO OCEAN SENSORS

A. Description

The systems were developed for the NOAA Data Buoy Office (NDBO) by Westinghouse Electric Corporation (WEC). NDBO has requested NOIC to perform a limited evaluation on two systems on a reimbursable basis.

One Ocean Sensor contains an Edo Western Acoustic Doppler current meter. The acoustic doppler works on the principle that a doppler shift occurs to the frequency of a transmitted acoustic signal by water particles in the beams axis. The doppler shifted frequency is detected by a receiver and is proportional to velocity.

A second Ocean Sensor contains an MMI electromagnetic current meter and operates as a self-contained system. The transducer is an MMI Model 750 EMCM with two measurement axis. A flux-gate compass is used for orientation to North and the system is vaned into the flow. All information is digitized and recorded internally on cassette magnetic tape.

B. Progress

Steady flow velocity tests were performed on the NSRDC tow carriage and Circulating Water Channel on both units. A significant blockage effect was noted on the EMCM unit because of the transducers mounting location. Tests are being performed at the NOL Acoustic Facility to determine the beam pattern of the doppler sensors. Additional information on the necessary directivity patterns of the acoustic doppler current meter can be found on page 8.

C. Future Plans

Laboratory tests will be completed and heave dynamics tests will be performed at NSRDC.

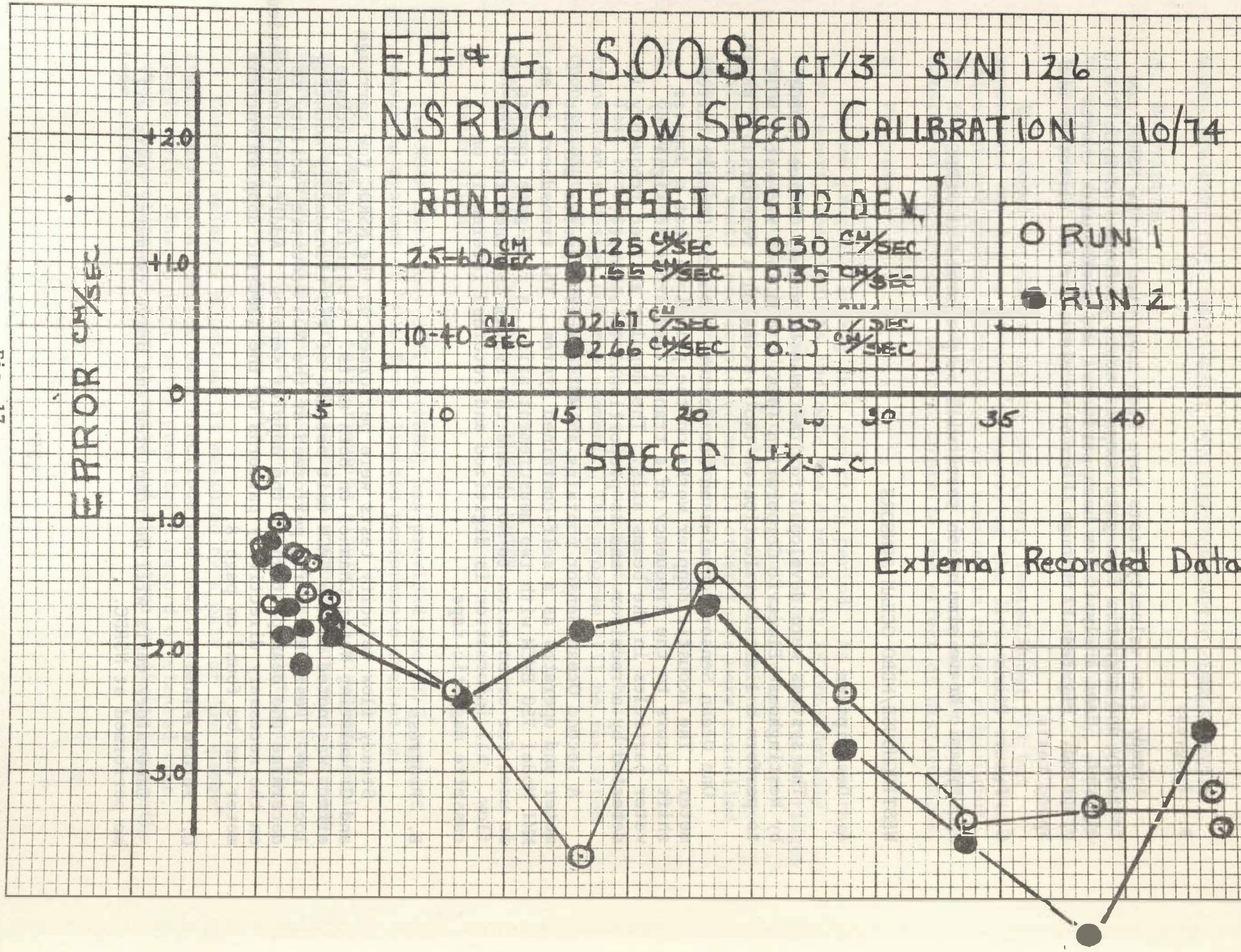

EG&G 5005 CT/3 S/N 126
NSRDC Low Speed Calibration 10/74
RANGE OFFSET STD DEV
2.5-6.0 CM/SEC
1.25 CM/SEC
0.30 CM/SEC
0.35 CM/SEC
10-40 CM/SEC
2.66 CM/SEC
O RUN 1
RUN 2
ERROR
+2.0
+1.0
0
-1.0
-2.0
-3.0
5
10
15
20
35
40
SPEED
External Recorded Data

Fig. 17

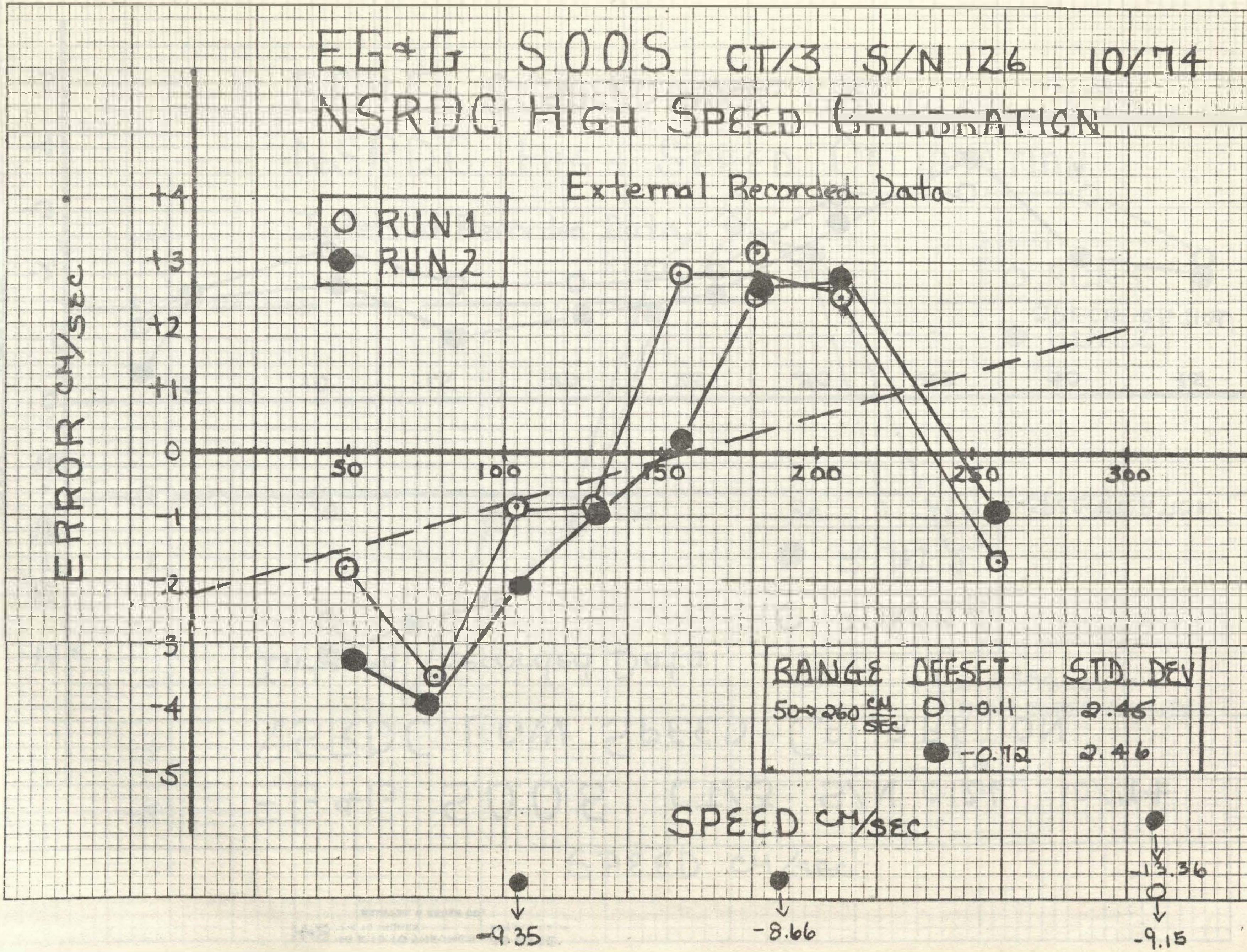

EG&G 5005 CT/3 S/N 126 10/74
NSRDC HIGH SPEED CALIBRATION
External Recorded Data
O RUN 1
● RUN 2
ERROR CM/SEC
+4
+3
+2
+1
0
-1
-2
-3
-4
-5
50
100
150
200
250
300
SPEED CM/SEC
RANGE OFFSET STD. DEV
50→260 CM/SEC O -0.11 2.46
● -0.12 2.46
-9.35
-8.66
-13.36
-9.15

Fig. 18

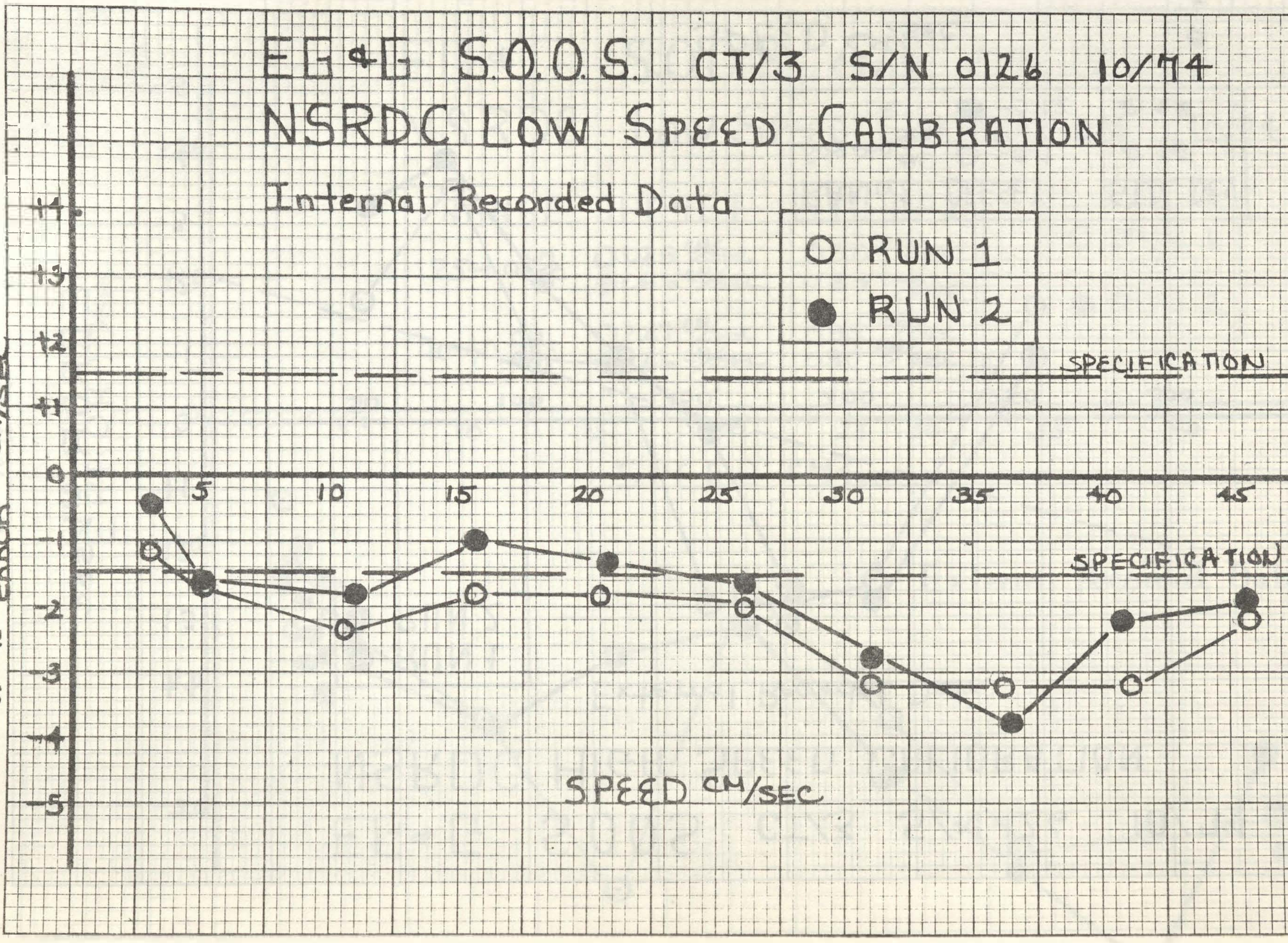

EG&G S.O.O.S. CT/3 S/N 0126 10/74
NSRDC LOW SPEED CALIBRATION
Internal Recorded Data
O RUN 1
● RUN 2
SPECIFICATION
SPECIFICATION
ERROR CM/SEC
+4
+3
+2
+1
0
-1
-2
-3
-4
-5
5
10
15
20
25
30
35
40
45
SPEED CM/SEC

Fig. 19

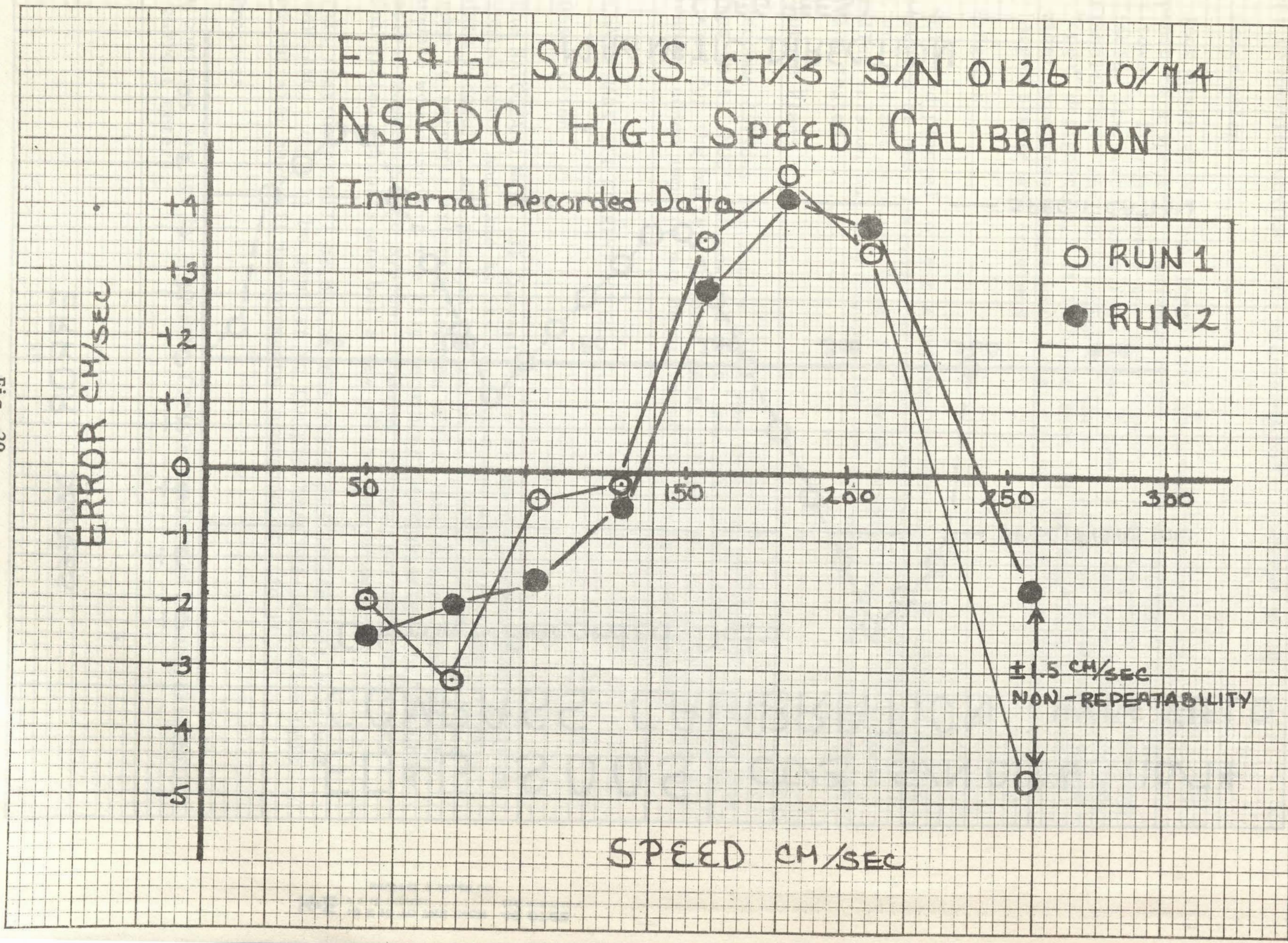

EG&G SOOS CT/3 S/N 0126 10/74
NSRDC HIGH SPEED CALIBRATION
Internal Recorded Data
O RUN 1
● RUN 2
ERROR CM/SEC
+4
+3
+2
+1
0
-1
-2
-3
-4
-5
50
150
200
250
300
SPEED CM/SEC
±1.5 CM/SEC
NON-REPEATABILITY

Fig. 20

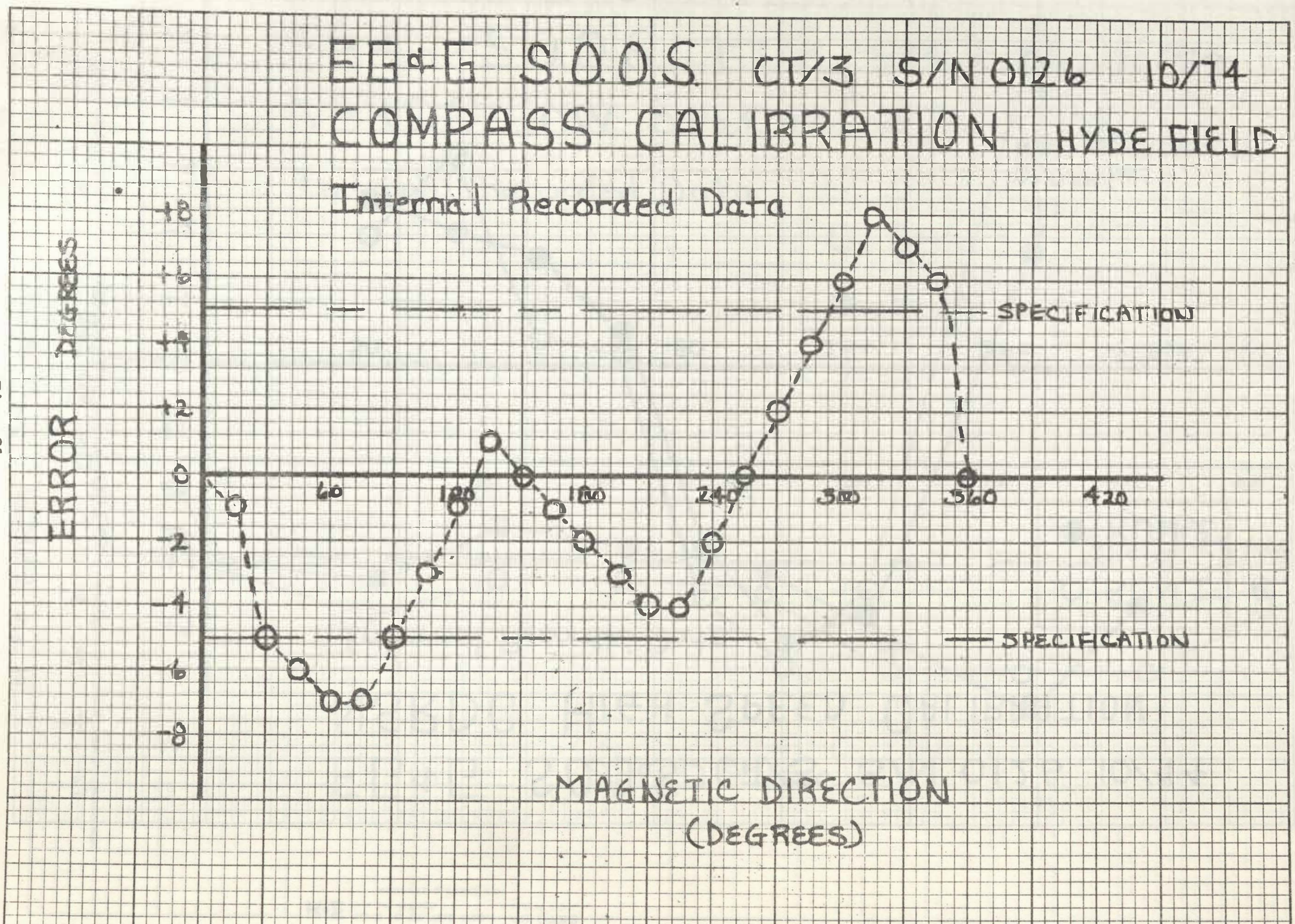

EG&G S.O.O.S. CT/3 S/N 0126 10/74
COMPASS CALIBRATION HYDE FIELD
Internal Recorded Data
ERROR DEGREES
+8
+6
+4
+2
0
-2
-4
-6
-8
60
120
180
240
300
360
420
SPECIFICATION
SPECIFICATION
MAGNETIC DIRECTION
(DEGREES)

Fig. 21

NAVAL UNDERWATER CENTER (NUC) ELECTROMAGNETIC CURRENT METER

A. Description

Jack Olsen of NUC developed this instrument several years ago in response to a specific requirement for current measurement from NUC's test tower. It represents the only "open" electromagnetic configuration available. Its distinction from other EMCMs is in the transducer design; a Helmholtz coil inside of which is placed 2 pairs of electrodes, hence the "open" designation. It is hoped that the hydrodynamic problems of the other type transducers will be minimized in this design because of the larger sample are involved.

B. Progress

NOIC had planned to test a battery powered unit to be developed and constructed at NUC, however, the project has been low priority within NOIC and has not received funds for timely completion. In the interim a smaller version built by Scripps for low velocity bottom measurements is being tested.

C. Future Plans

Recommendations for future plans are awaiting results of testing the Scripps unit. NUC's AC powered unit, now available, may be tested rather than wait for the battery powered unit. If results of these tests prove favorable, added impetus may be approved for further development.

NAVOCEANO MARK III CURRENT METER

A. Description

The NAVOCEANO Mark III Current Meter is an instrument that utilizes a Savonius rotor and vane as its current speed and direction sensors. The data recording and processing system is unique and was developed in order to retrofit existing Geodyne meters now in use. The retrofit and update would convert the film recording Geodyne meters to computer compatible magnetic tape system. Modular design, gel cell batteries and integrated circuits are but a few of the improvements.

This instrument will be one of the first production unit received by NAVOCEANO. It will be similar to the previous pre-production unit tested but will have all improvements incorporated into it.

B. Progress

A contract was let by NAVOCEANO for the production of approximately five current meters.

C. Future Plans

A complete evaluation will be performed when a unit is received from NAVOCEANO which is now scheduled for July 1975.

CURRENT METER DYNAMIC RESPONSE STUDY

A. Description

The dynamic response characteristics of a current speed and direction sensor may severely limit its in situ measurement capabilities. For example, it has been found that platform/mooring motions introduce significant errors in the average current vector measured by current meters supported by moorings. Also, the imperfect dynamic response characteristics inherent in current meters present additional measurement deficiencies for near surface current determinations (wave water particle region).

Historically, almost all current meter performance evaluations conducted in the laboratory have been under steady flow conditions. Unfortunately these conditions are not very representative of the typical in situ environment. Therefore, in July 1972, NOIC initiated a program to develop realistics dynamic test standards for current meters.

B. Progress

No significant progress has been made this reporting period. As reported previously, a single dynamic test fixture capable of simultaneously imparting two degrees of freedom (simulating longitudinal, lateral, vertical/horizontal elliptical, vertical orbital motion) has been conceptually designed. This fixture, to be used on the NSRDC tow carriage, will be capable of testing full size current meters at up to 4 foot peak-to-peak amplitudes (adjustable) and from 12 to 3 second periods. It is envisioned that once this fixture has been fabricated and validated it will be utilized for current meter dynamic investigations. This program has been delayed due to other testing projects and lack of funds to build the test fixture.

C. Future Plans

Refinement of the capabilities of a vertical mooring oscillation detector which will be used to obtain field data on several mooring time configurations. The motion detector will be refined by using burst sampling and a faster recorder to obtain greater resolution.

The fabrication and validation of the dynamic test fixture will commence when the funding is available ($50K minimum). Permission from NSRDC to allow this device on their tow carriage is also required.

WAVE AND TIDE MEASURING INSTRUMENTATION

TESTING PROGRAM

Date: January 1, 1975

Project: Waves and Tides
Project Leader: R. Ribe

N — Navy **R** — Reimbursable
I — In-House **O** — Other

Task Description	FY'75 J	A	S	O	N	D	J	F	M	A	M	J	FY'76 J	A	S	O	N	D	J	F	M	A	M	J	Req'mt.
Improved Baylor Model 9737									■	■	■	■	■												I
Bass Engineering Model STG 100														■	■	■	■								I
Western Marine Electronics SLM 15W			■	■	■	■	■	■																	I
Water Conductivity Effects on Wave Staffs	■																								N
Summary report on:	■	■	■	■																					N
Ocean Research Equip., Model 480																									
Bendix, Model Q17																									
Edo Western, Model 389																									

BAYLOR 9737 WAVE RECORDING SYSTEM

A. Description

This is a wave staff, complete with power supply, staff, signal processing, and an analog, strip-chart recorder. The staff consists of twin, parallel, 1/2 inch-diameter, stainless steel, wire ropes spaced nine inches apart and offered in lengths up to 100 feet. Ocean tests by Coastal Engineering Research Center show that fouling is much less a problem with this parallel cable design.

A sealed transducer electronics package is mounted at the upper end of the staff cables. The lower ends of the staff cables are electrically and mechanically shorted together. These cables function as a section of shorted transmission line. The transducer generates a radio frequency sine wave of approximately 650 kHz and sends this stimulus down the staff cables. The wave length at this frequency is much longer than the staff cable length. The voltage amplitude of this sine wave is proportional to the length of wave staff above the water surface. This sine wave is rectified and variations in amplitude used as a measure of variations in water wave height.

Power source for the system is 115 V., 60 Hz. No timer-programmer of strip-chart speed or operation is provided, although recorder-chart speed can be changed manually in incremental fashion.

B. Progress

No additional work on this system during this reporting period.

A written, tutorial paper describing this and other wave instruments in existence and a tutorial oral talk on accuracy of wave measurement were presented at a plenary session of the WAVES'74, Ocean Waves Measurement and Analysis Symposium, New Orleans, September 9-11, 1974.

C. Future Plans

Baylor Corporation has redesigned the transducer and power supply, improving linearity and stability. We plan to buy the redesigned system.

WESTERN MARINE ELECTRONICS MODEL SLM15W WAVE HEIGHT LEVEL MONITOR

A. Description

The Western Marine Electronics Model SLM15W is a variation of a device used to measure level of stored liquids. It has all solid state electronics and contains circuits for measurement of the transit time interval of sound from the transducer down to the ocean surface.

The electronics sends a series of pulses to the ceramic piezoelectric transducer, which are transformed into acoustical pulses. The echoes received from the ocean surface by the same transducer are detected and amplified. The electronics then produce a DC voltage and current output proportional to wave height. The modified unit being tested is a prototype. Transmitted pulses are specified as modulation of 12 kHz carrier with 12 degree beam width. Range of measurement is from 3 feet to 23 feet from the transducer.

B. Progress

A test plan is being prepared and test apparatus assembled. Preliminary laboratory tests were conducted using a piece of plywood as a target. The plywood was spaced at known distances from the SLM15W transducer and wave system output measured as a calibration (figure 22). In addition, a plywood disk was attached to the panel such that it was one foot closer to the transducer and with center at the beam center. The farthest distance from the transducer at which the disk was sensed versus disk diameter provided a measure of wave instrument resolution (figure 23).

Some study of instrument electronic function has been conducted.

C. Future Plans

Continue with the evaluation with emphasis on specific properties of this type of acoustic instrument including resolution and acoustic interference.

WATER CONDUCTIVITY EFFECTS ON A NAVAL RESEARCH LABORATORY

A. Description

The Naval Research Laboratory uses a spiral-wound, resistance wave staff in low salinity waters for acoustic studies and wanted a determination of effects of salinity and temperature variations (water conductivity variations). The staff uses constant current amplitude, sinusoidal stimulus.

B. Progress

Tests results were described previously. Some analysis work concerned with contributions from the circuit elements in the constant current mode of operation has been performed but no significant conclusions can be made yet.

C. Future Plans

Continued study of the large difference in water electrical conductivity effects between the NRL staff and two other staffs will continue when time is available.

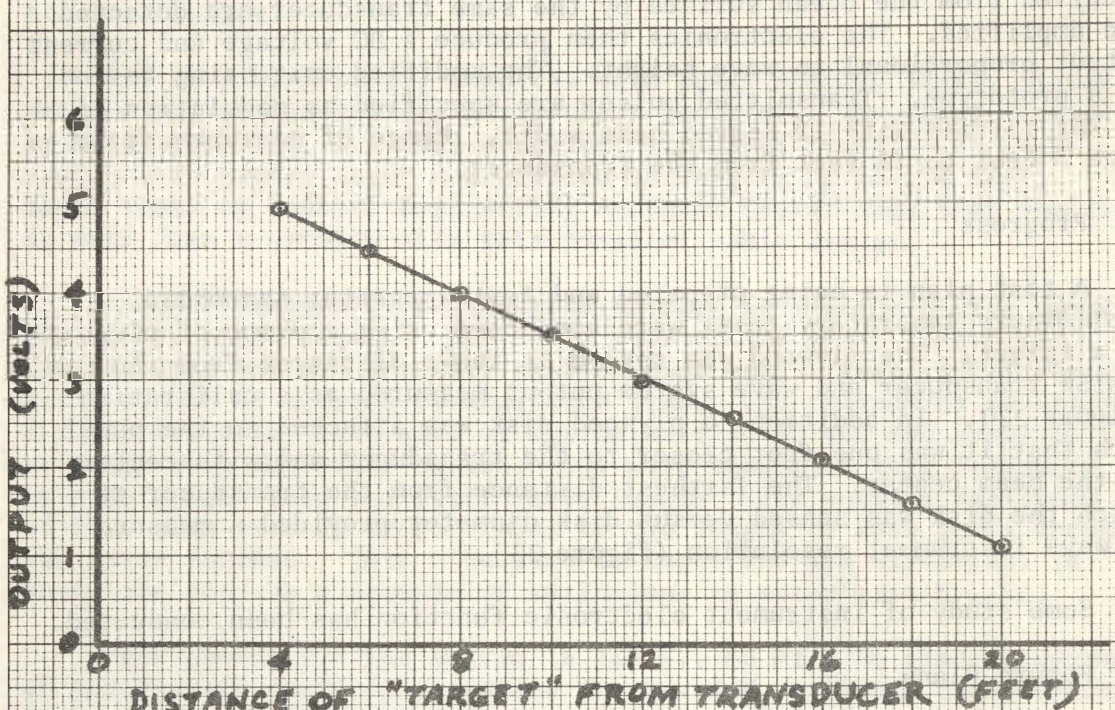


FIGURE 22.- LABORATORY CALIBRATION OF THE WESTERN MARINE ELECTRONICS, SLMISW, WAVE HEIGHT LEVEL MONITOR.

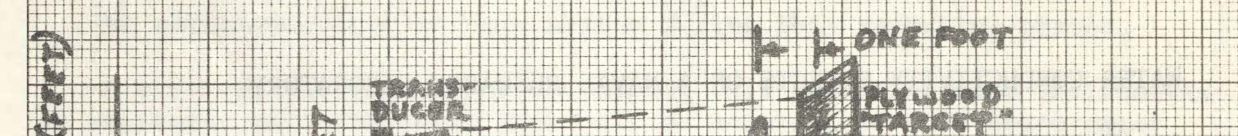


FIGURE 23.- ABILITY OF THE WESTERN MARINE ELECTRONICS MODEL SLMISW TO DETECT A PLYWOOD DISK PLACED ACROSS ACOUSTIC BEAM CENTER LINE.

OCEAN RESEARCH EQUIPMENT COMPANY MODEL 480 ACOUSTIC WAVE GAUGE

A. Description

The system directs an acoustic pulse from a bottom-mounted projector to reflect off the ocean surface and return to the acoustic transducer acting as a hydrophone. Transit time of the acoustic pulse is measured as the number of cycles of a crystal-controlled oscillator occurring during the transit time and converted to an analog voltage. Elaborate gating and frequency dividing systems are used to vary pulse repetition rate, range scales, and to allow pulses to be projected before previous pulses have returned (increasing allowable depth of immersion, while still allowing high repetition rates). The transducer can be immersed to 1,000 feet without (theoretical) loss of resolution of water-height measurement, but will result in degraded wave shape resolution. Immersion beyond 1,000 feet, but less than 2,000 feet, will degrade accuracy of water height measurement because of necessity to change range scale.

An analog recorder is provided. Power source is 115 V., 60 Hz. The projector-receiver transducer has about ±1.3° directivity angle for 3 db down in power.

B. Progress

Most of the tests of the ORE 480 have been summarized previously.

The system was mounted on a submarine by NSRDC and wave and submarine depth measurements were made for a number of different submarine depths. Additional tests are being conducted. Preliminary test results are shown in figure 24.

An informal report has been written summarizing the test results.

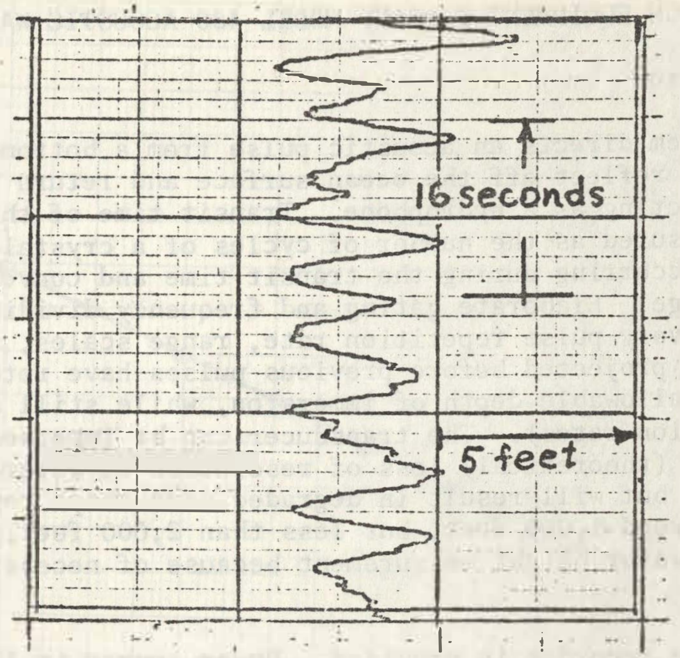
C. Future Plans

No other work is planned.

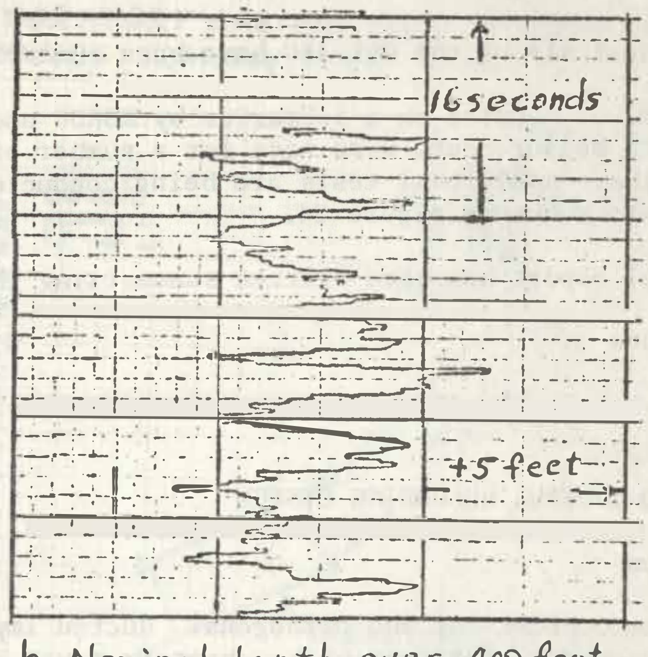
BENDIX MODEL Q-17 WAVE RECORDING SYSTEM

A. Description

This system consists of two orthogonal, ducted impeller, ocean current speed sensors, together with a battery power supply and signal processing electronics. The two impellers are supplied with switchable electronic time constant, 0.2 seconds or 2 seconds on low range to measure two components of waves (vertical and one horizontal or both horizontal) and 20 second time constant on low range to



a. Nominal water depth of transducer = 25 feet
Sample rate = 4.8 per second



b. Nominal depth over 400 feet and 17 hours after a.
Sample rate = 2.4 per second.

Figure 24 - Sample results of submarine-mount tests by Naval Ship Research and Development Center with the O.R.E, Model 480 Acoustic Wave Gage.

average perturbations and to provide the more steady-state components. On high range, the rated time constants are 0.04, 0.4 and 4.0 seconds. Low speed range is 0 to 1 knot; high speed, 0 to 5 knots.

The ducts, each four inches in diameter by eight inches long, contain a five-bladed impeller with a magnet in each blade tip. The magnets close reed switches to provide electrical pulses, which are processed by solid-state circuitry to form an analog voltage. These voltages for the two ducts are displayed by separate panel voltmeters and connected to separate output jacks for a connection to a user-supplied analog recorder. Positive or negative flow through each duct is determined by which of two reed switches, set side by side in the wall of the duct, closes first.

B. Progress

Most of the tests on the Q-17 have been described previously.

An informal report has been written summarizing test results.

C. Future Plans

Present plans are to discontinue evaluation of the Q-17.

EDO WESTERN MODEL 389 WAVETRAK WAVE-HEIGHT-SENSING SYSTEM

A. Description

The Wavetrak is an acoustic-based wave measurement system. A projector, designed to be immersed from 10 to 100 feet below the ocean surface projects narrow beam acoustic pulses upward toward the ocean surface and wide beam toroidal pulses to a "remote" hydrophone. The narrow beam (4°), pulse reflects off the ocean surface and returns to the 200 kHz transducer now acting as a hydrophone. Solid state electronics process the return pulse and transmit it through the wide beam (40°) 24 kHz projector. These pairs of pulses out of the wide beam projector are repeated at 150 msec intervals. Spacing between the pulses in each pair is a measure of instantaneous wave height. The pulse pairs are received by the remote hydrophone, processed by electronics remote from the transducer and displayed on a voltmeter or optional strip-chart recorder.

The projectors are powered by rechargeable batteries. The signal processing and recorder are powered by 115 V., 60 Hz. Automatic range switching and programming are available.

The projectors can be mounted on a subsurface buoy, thereby allowing deep water wave measurements.

B. Progress

Most of the tests on the Wavetrak have been described previously.

An informal report has been written summarizing test results.

C. Future Plans

No further evaluation work is planned.