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1980 LAKE ERIE PHYSICS PROGRAM

Project Leader: F.M. Boyce
Basin Investigation & Modelling Section
Aquatic Physics & Systems Division

By: M.R. Mawhinney
Technical Operations Division
National Water Research Institute

UNPUBLISHED REPORT
RAPPORT NON PUBLIE

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ACKNOWLEDGEMENTS

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A special thanks to Mrs. S. Mitchell for typing, arranging and presenting this report in its present form and whose time and effort went into its completion.

SUMMARY

The 1980 Lake Erie Physics Program was the conclusion to the study initiated in 1979. The project overall this season did not have the same duration as 1979. Two vessels were used to support this project (80-509), the CSS LIMNOS (mooring installation and retrievals and Anchor Station Experiment) and the CSS ADVENT (FTP monitors, tide gauge mooring installation, CATTS, contact cruises, meteorological systems mounts and VAPS support). A total of 29 moorings were established during the 1980 field season:

13 current meter moorings
4 fixed temperature profiler moorings
3 meteorological moorings
5 tide gauge moorings
2 CATTS (current and temperature turbidity system)
1 wave rider buoy
1 M-CATS

The LIMNOS became involved in only one anchor station this season compared to three conducted during the 1979 field season. The ADVENT completed seven (7) thermocline cruises, five (5) mid-lake sampling surveys and gave support to the LIMNOS by acting as a shuttle craft for scientific staff and equipment to and from Erieau.

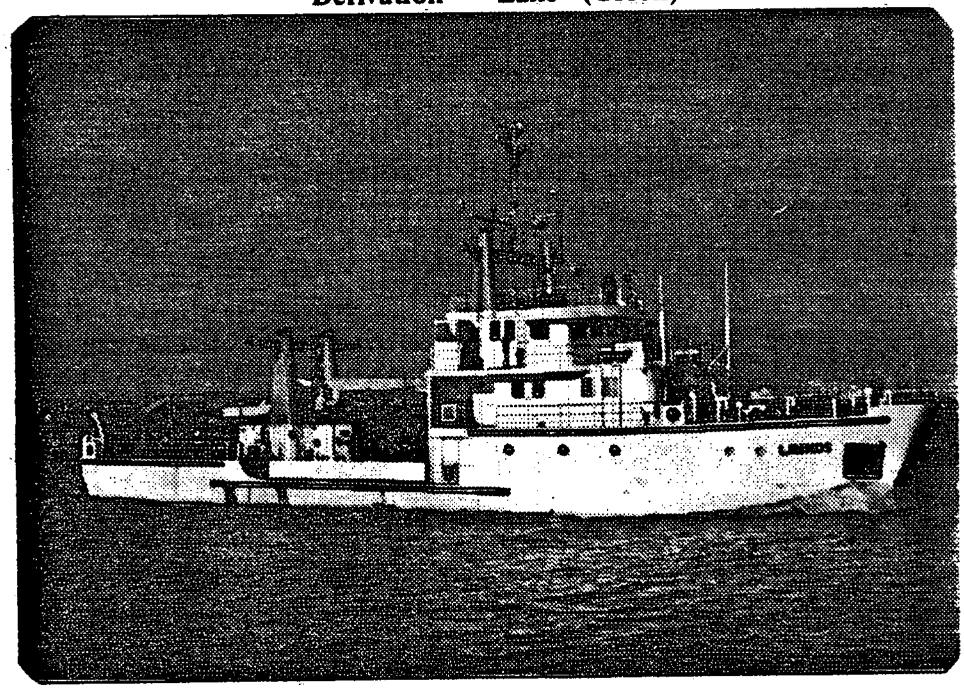
INTRODUCTION

This report documents the support given the 1980 Lake Erie Physics Program. It is not intended to be a scientific report but a Technical Operations operational report as to equipment, procedures and data return used and experience during the field season. There are four main areas of discussion in this report: Ship Support, Moorings and Buoy Systems, Anchor Station and Temperature and Thermocline Contact Studies.

The 1980 field study was shorter in duration but larger in magnitude as to actual sampling and support required at the peak of the intensive period during the 1979 field season.

"LIMNOS"

Derivation – "Lake" (Greek)



TYPE Limnology research vessel, also designed for Hydrographic Surveys. Steel hull

YEAR BUILT	*LENGTH*	*BEAM*	*DRAFT*	*DISPLACEMENT*	*TONNAGE*	
					GROSS	*NET*
1968	147′	32′	8′ 0′	Light 504 Loaded 615	459.94	173.04

PERFORMANCE

SPEED (KNOTS)			*RANGE*	*ENDURANCE*
CRUISING	*MAXIMUM*	*MINIMUM*		
10	11	2	2000 miles	14 days

COMPLEMENT

CREW	*SCIENTIFIC STAFF*
16	14

CSS LIMNOS

ORIGIN

The vessel was built by Port Weller Dry Docks Limited at St. Catharines, Ontario. Steel hull, Limnology Research Vessel/ Hydrographic Surveys. Port of Registry - Ottawa.

EQUIPMENT

The Engines are two 500 B.H.P. at 1250 RPM Paxman Diesels, keel cooled, twin 360° rotatable Harbourmaster units; fixed-pitch propellers, right angle drive gears and vertical shafting; bridge or engine room controlled; the vessel is steered by turning the propeller assemblies, thus eliminating the need for rudders.

Bunker Capacity - 71.84 long tons/18,307 Imp. Gals.
Fresh Water Capacity - 59.95 long tons/13,444 Imp. Gals.

Electrical Power supply is from two Cummins Diesel Generators, 150 K.W. each. An Emergency Cummins Diesel Generator, 100 K.W. will start automatically should there be a failure of whichever main generator is in use. It can be put in parallel with the main generators.

Summer sea load - 110 amps
Winter sea load - 168 amps

The remaining power can be used for scientific apparatus and instruments.

Ship's System - 460 volt, 3-phase 60-cycle A.C.

Transformer Requirements - 240 volt, 3-phase
120 volt, 3-phase

Two laboratory controlled frequency stabilized units rated at 5 KVA, output supply 115 volt, single phase, 60-cycle.

Power available for laboratory purposes:

Type	Transformer Capacity	Power Available
460V.-60 Hz-30		100 K.W.
230V.-60 Hz-30	72 K.W.	10 K.W.
120V.-60 Hz-30	135 K.W.	30 K.W.

NAVIGATION EQUIPMENT

Radar fitted in the vessel is:

Decca Radar Model RM1226C
Decca Radar Model RM1229

Radio fitted in the vessel is:

1 - Collins MR-201 VHF/FM Transceiver
1 - Spilsbury & Tindall - SBH 125 - AM Transceiver

Compasses/Repeaters fitted in the vessel are:

Arma-Brown Gyro Compass Mk. 10 Master Compass in Operational Control Centre: 9 Repeaters - 2 in Radar Displays; 1 in Wheelhouse, 1 in Engine Room Control Consol/Remote Control, 1 in Consol on starboard wing of Bridge; 3 Bearing Repeaters on Bridge; plus 1 Repeater in starboard laboratory.
Gyro Compass Course Recorder
Sperry Automatic Pilot
Standard Magentic Compass
Direction-Finder - Automatic Type 511
Wind Speed/Direction Indicators on Bridge and in laboratory
Searchlight
Bergen-Nautik retractable Pitometer Log Type FEN-2

Depth Sounders fitted are:

1 Kelvin Hughes Model M526B
2 Simrad Model EP2BN
1 Atlas

HYDROGRAPHIC WINCHES & EQUIPMENT

All winches are mounted on portable bases which enable them to be positioned anywhere on deck on 22" centres. The winches are placed onboard as required.

One single drum heavy duty electro-hydraulic winch, J. Swann Series '0'-329 Mk2 Model 80, 40 H.P. two-speed, Rating: 4 tons, slow speed - 2 tons, high speed. Capacity - 5,000 ft. 1/2" wire or equivalent. Two readouts - one portable free-fall clutch with brake may be fitted with a maximum of 10 slip rings, rotatable, automatic spooling, remote control available.

One wire winding winch, electro-hydraulic, J. Swann Series '0'-325, 5 H.P., various drum capacities from 30,000 ft. of 3/32" to 2,500 ft. of 5/8" wire. Detachable drum. May be used for light duty oceanographic work. Automatic spooling.

One New England Trawler, 2 speed, 2 direction Capstan.

One light duty oceanographic winch, electro-hydraulic or diesel powered, J. Swann Series '0'-365, 10 H.P. two-speed, rating 800 lbs. slow speed, 400 lbs. high speed. Drum capacity - 2,500 ft., 5/32" wire, free-fall clutch with brake. Slip rings may be fitted, rotatable, automatic spooling, remote control available.

Two light duty EBT winches, electro-hydraulic, J. Swann Series '0'-315, 5 H.P. Drum capacity - 4,000 ft., 3/32" wire, speed 540 ft. per radius (maximum radius 35 ft.) capable of 360° rotation. Drum capacity 270', 1/2" wire. Located amidships.

Two fixed 'A' frames	- 1,000 lbs.
Two portable 'A' frames	- 3,000 lbs.
Two portable gallows	- 3,000 lbs.

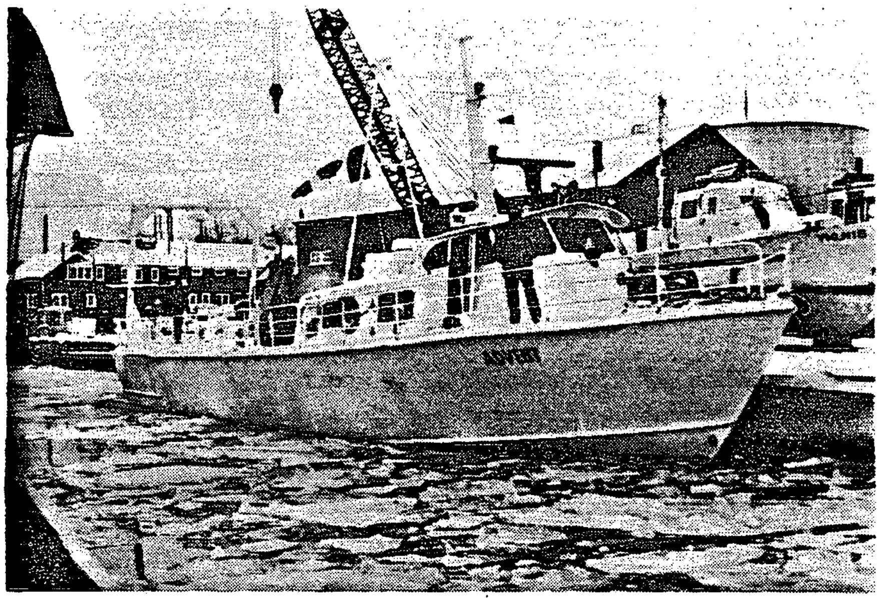
One Austin Western Model 410-P electro-hydraulic crane - 40 H.P., 6,000 lbs. lift at 26 ft. working radius and 10,000 lbs. lift at 12 ft. working radius (maximum radius 35 ft.) capable of 360° rotation. Drum capacity 270', 1/2" wire. Located amidships.

One HIAB Model 177S marine articulated crane with double acting hydraulic rams, 20 H.P., maximum outreach 18 ft., capable of lifting 2,000 lbs. at 25 ft./min. with 17 ft. radius capable of 360° rotation. Drum capacity 250 ft., 3/8" wire. Located on after deck, starboard side.

LABORATORY SPACE

The Laboratory, measuring 670 sq. ft. is amidships with access to port and starboard main deck. Storage limited. Wet laboratory with sounding chain, 90 sq. ft. on starboard side connecting to the Main Laboratory.

"ADVENT"



TYPE Limnological and Hydrographic Survey Vessel Aluminum Hull

Year Built	Length	Beam	Draft	Displacement	Tonnage	
					Gross	Net
1972	77′	17.6′	5′	Light 45T. Loaded 56T.	71.54	39.49

PERFORMANCE

Speed (Knots)			Range	Endurance
Cruising	Maximum	Minimum		
20	22	4	600 miles	30 hours

COMPLEMENT

Crew	Scientific Staff
4	8

CSS ADVENT

ORIGIN

The vessel was built by the Alloy Manufacturing Company at Montreal, Quebec. All welded Aluminum hull, Limnology Research Vessel/ Hydrographic Surveys. Port of Registry - Ottawa.

EQUIPMENT

The Engines are two turbo-charged V-12 71 Detroit Diesels, 1020 B.H.P. Fixed-pitch propellers; electric starting. Controlled from the Bridge. Port propeller left-hand turning, starboard propeller right-hand turning.

Bunker Capacity - 3.99 long tons/1,142 Imp. Gals.
Fresh Water Capacity - 11.2 long tons/2,511 Imp. Gals.

Electrical Power supply is from two Detroit Diesel Generators, 30 KW each. There are facilities for shore power hook-up 230 V. A.C.

Ship's System - 220 volt, single-phase, 60-cycle A.C.
Normal working Load - 15 amps.

There are 24 V., 110 V. and 230 V. power outlets in the Laboratory.

NAVIGATION EQUIPMENT

Radar fitted in the vessel is:

Kelvin Hughes Model 17/9 (Relative Motion only)

Radio fitted in the vessel is:

1 - Raytheon Ray 50 VHF/FM transceiver

Compasses/Repeaters fitted in the vessel:

Arma-Brown Gyro Compass Mk.10 Master Compass in laboratory
1 Repeater in Wheelhouse
Remote electric steering device - 24 V. supply
Portable Danforth Magnetic Compass
Wind Speed/Direction Indicators in Wheelhouse
Searchlight

Depth Sounders fitted are:

1 - Ross Sounder Model 200-A in Wheelhouse
1 - Atlas DESO-10 in Laboratory

HYDROGRAPHIC WINCHES & EQUIPMENT

One SKB Type 9TM22 hydraulic crane capable of lifting 1,800 lbs. with 20 ft. radius and an arc of rotation of 315°. Located amidships, aft.

One wire winding hydraulic winch, J. Swann Series '0'-490. Drum capacity 1,500 ft. of 5/32" wire. Rating 250 lbs. at 350 ft./min. Meter block may be rigged as required. Located port side, aft of cabin structure.

A hydraulic operated 'A' frame may be mounted on the stern if required; 13 ft. high with a lifting capacity of one ton and a towing capacity of 1,500 lbs. at 10 knots.

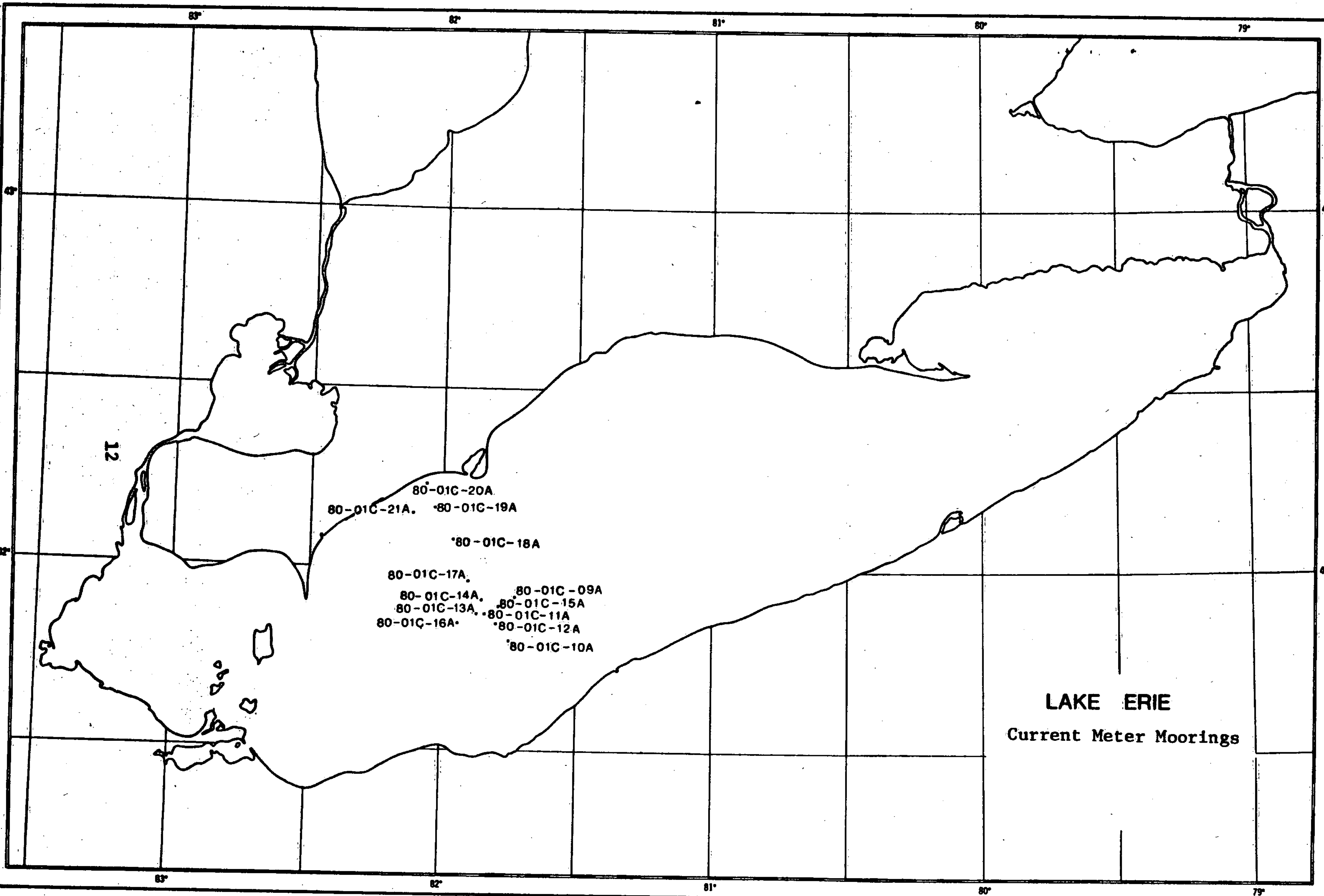
LABORATORY SPACE

The laboratory has an area of approximately 90 sq. ft. and is situated amidships, abaft the wheelhouse and crew's living space. A door leads out of the after end of the upper deck. The laboratory is fitted with a sink, flat-top counter and storage cupboards.

CHRONOLOGY OF EVENTS

July 14 - 17	- Current meter, meteorological and FTP mooring installation
July 21	- ADVENT commenced support to Project No. 509 and installed 4 tide gauge moorings
July 26	- ADVENT began temperature mapping and thermocline contact cruises
July 29	- ADVENT conducted 2nd thermocline contact cruise
August 6	- 3rd contact cruise conducted
August 8	- 4th thermocline contact cruise conducted
August 11	- LIMNOS departed CCIW for Station C11 on Lake Erie
August 12	- ADVENT conducted 5th thermocline cruise - LIMNOS anchored on Station C11
August 13	- ADVENT conducted 1st mid-lake survey and rendezvoused with LIMNOS - LIMNOS deployed tide gauge mooring M-CATS and anchors
August 14	- ADVENT conducted 2nd mid-lake survey
August 15	- ADVENT conducted 3rd mid-lake survey - LIMNOS retrieved and relocated drogues
August 16	- LIMNOS at Station C11
August 17	- LIMNOS at Station C11
August 18	- LIMNOS at Station C11 - Rosette failed in early morning sampling
August 19	- ADVENT conducted 4th mid-lake survey - LIMNOS at Station C11
August 20	- LIMNOS at Station C11 - ADVENT conducted 5th (last) mid-lake survey

August 21	- ADVENT conducted 6th thermocline contact cruise - LIMNOS retrieved wave rider, sediment trap, M-CATS and drogues - Departed Station C11
August 22	- LIMNOS arrived Port Colborne - Completed Anchor Station Cruise
August 26	- ADVENT stripped Met. buoys and FTP moorings
August 27	- ADVENT conducted 7th thermocline contact cruise
August 28	- ADVENT conducted 8th and final thermocline contact cruise
September 2 - 5	- LIMNOS retrieved all moorings installed in the lake during study period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80-01C-15A
80-01C-11A
80-01C-12A
80-01C-10A
LAKE ERIE
Current Meter Moorings

CURRENT METER MOORINGS

TYPES OF CURRENT METERS

The current meter arrays consisted of the following types of meters:

a) Plessey Current Meters: All of these meters have a helical Roberts type impeller. They are suited for near-surface installation and were installed at either a 10-metre or 14-metre depth.

b) Geodyne Current Meters: These instruments have a Savonius rotor and are not suited to near-surface installations. These meters were installed in a minimum depth of 18 metres of water which was in close proximity to the bottom depth.

CURRENT METER INSTALLATIONS

Thirteen current meter moorings were deployed during the week of July 14 - 17 cruise aboard the CSS LIMNOS. These moorings consisted of 18 M021 Plessey current meters, 15 Geodyne current meters, 3 RCM12 Plessey meters and 2 9021 Plessey current meters.

The installations went smoothly and all moorings were in position within three days. There was no changeover of meters this year as the moorings were in position for only a seven-week period. The Plessey meters had 10-minute cams and the Geodyne meters had 20-minute cams.

POSITIONING OF CURRENT METER MOORINGS

The LIMNOS was utilized in the installation of all current meter moorings on Lake Erie this field season. The methods used for positioning of the vessel before the deployment of these moorings was by ship's radar and Loran C navigation. At each site, when the instruments were installed, a bearing and distance from one or two known points of land were obtained where possible and logged; simultaneously, a Loran C reading was taken and logged. This procedure was carried out again when the surface marker was placed in position. The latitudes North and longitudes West of positions were logged from the Loran C co-ordinate converter thus enabling the vessel to return to the original position, irrespective of which Loran C chain was on the air.

Acoustic releases were placed on the instrument anchors of all current meter moorings which were moored in the most precarious positions; i.e.: mooring placed in close proximity to shipping lanes. This additional positioning method was used to ensure recovery operation ease in locating the instrumentation if surface markers had gone adrift. The positioning systems used were:

Radar:	Decca Radar RM1226C Decca Radar RM1229
Loran C:	Internav Receiver LC123 Co-ordinate Converter CC2
Acoustic Pingers:	Hydro Products, Mesotech Systems Limited, Helle Engineering Incorporated

CURRENT METER RETRIEVAL

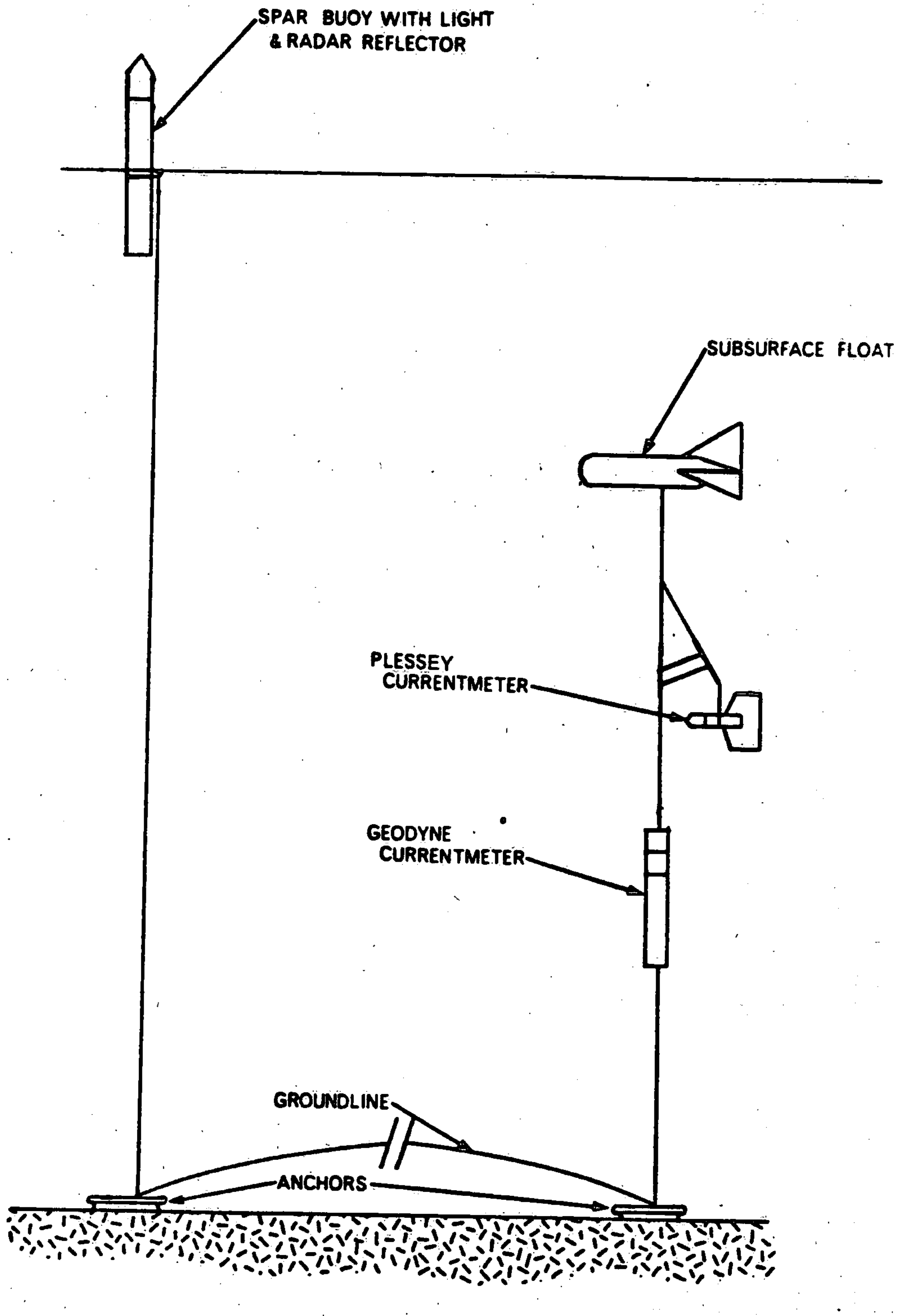
The retrieval of the current meter moorings together with the balance of the moorings, FTP, Met. buoy, etc., went very smoothly with fairly good weather conditions. This year, only one surface marker was lost which was a major improvement from the past several field seasons.

DATA RETURN FROM CURRENT METER MOORINGS

The overall data return from the current meter moorings (not considering the newer RCM12 and 9021 Plessey meters) averaged 85%. The RCM12's and the 9021's had very bad field records. Out of the 3 RCM12's deployed, one has the possibility of producing data while the return from the other 2 meters is impossible to decipher. The 9021's were not much better. There were two meters installed--one did not work at all and the other may have some data on it which could be recovered with a great deal of computer time.

CURRENT METER SUMMARY

MOORING NO.	LATITUDE N.	LONGITUDE W.	METER DEPTH	METER TYPE	METER NO.
80-01C-09A	41° 53' 34"	81° 44' 14"	10	M021 Plessey	211/457
			17	M021 Plessey	218/484
			22	Geodyne	010
80-01C-10A	41° 46' 07"	81° 46' 57"	10	M021 Plessey	236/516
			17	Geodyne	008
			20	Geodyne	029
80-01C-11A	41° 50' 38"	81° 50' 16"	10	M021 Plessey	212/461
			14	RCM12 Plessey	011/594
			17	M021 Plessey	291/767
			21	Geodyne	013
80-01C-12A	41° 49' 25"	81° 49' 46"	10	M021 Plessey	295/783
			14	RCM12 Plessey	007/434
			17	M021 Plessey	444/079
			21	Geodyne	020
80-01C-13A	41° 50' 02"	81° 52' 03"	10	M021 Plessey	449/100
			17	M021 Plessey	307/830
			21	Geodyne	031
80-01C-14A	41° 53' 00"	81° 51' 57"	10	M021 Plessey	225/514
			17	9021 Plessey	095/095
			21	Geodyne	001
80-01C-15A	41° 51' 57"	81° 47' 13"	10	M021 Plessey	299/799
			14	RCM12 Plessey	003/485
			17	M021 Plessey	422/1004
			21	Geodyne	011
80-01C-16A	41° 48' 07"	81° 56' 43"	10	M021 Plessey	294/779
			17	M021 Plessey	224/509
			20	Geodyne	021
80-01C-17A	41° 55' 41"	81° 54' 00"	10	M021 Plessey	300/804
			17	Geodyne	042
			21	Geodyne	007
80-01C-18A	42° 02' 29"	81° 58' 41"	10	M021 Plessey	296/787
			20	Geodyne	047
80-01C-19A	42° 09' 35"	82° 03' 36"	10	M021 Plessey	426/1021
			18	Geodyne	028
80-01C-20A	42° 12' 12"	82° 05' 31"	10	9021 Plessey	004/004
			14	Geodyne	049
80-01C-21A	42° 07' 18"	82° 09' 03"	10	M021 Plessey	425/1018
			19	Geodyne	003



TYPICAL U-SHAPED MOORING

CURRENT METER DATA RETURN SUMMARY

	TIME	VELOCITY	DIRECTION	TOTAL AVERAGE
Geodyne Meters:				
Total 15 meters	100%	100%	100%	100%
Plessey Meters (M021):				
Total 18 meters	71.5%	71.5%	71.5%	71.5%
2 did not function 2 gave faulty data				
Plessey Meters (9021):				
Total 2 meters	-	-	-	0%
Plessey Meters (RCM12)	-	-	-	0%

WATER LEVEL GAUGES

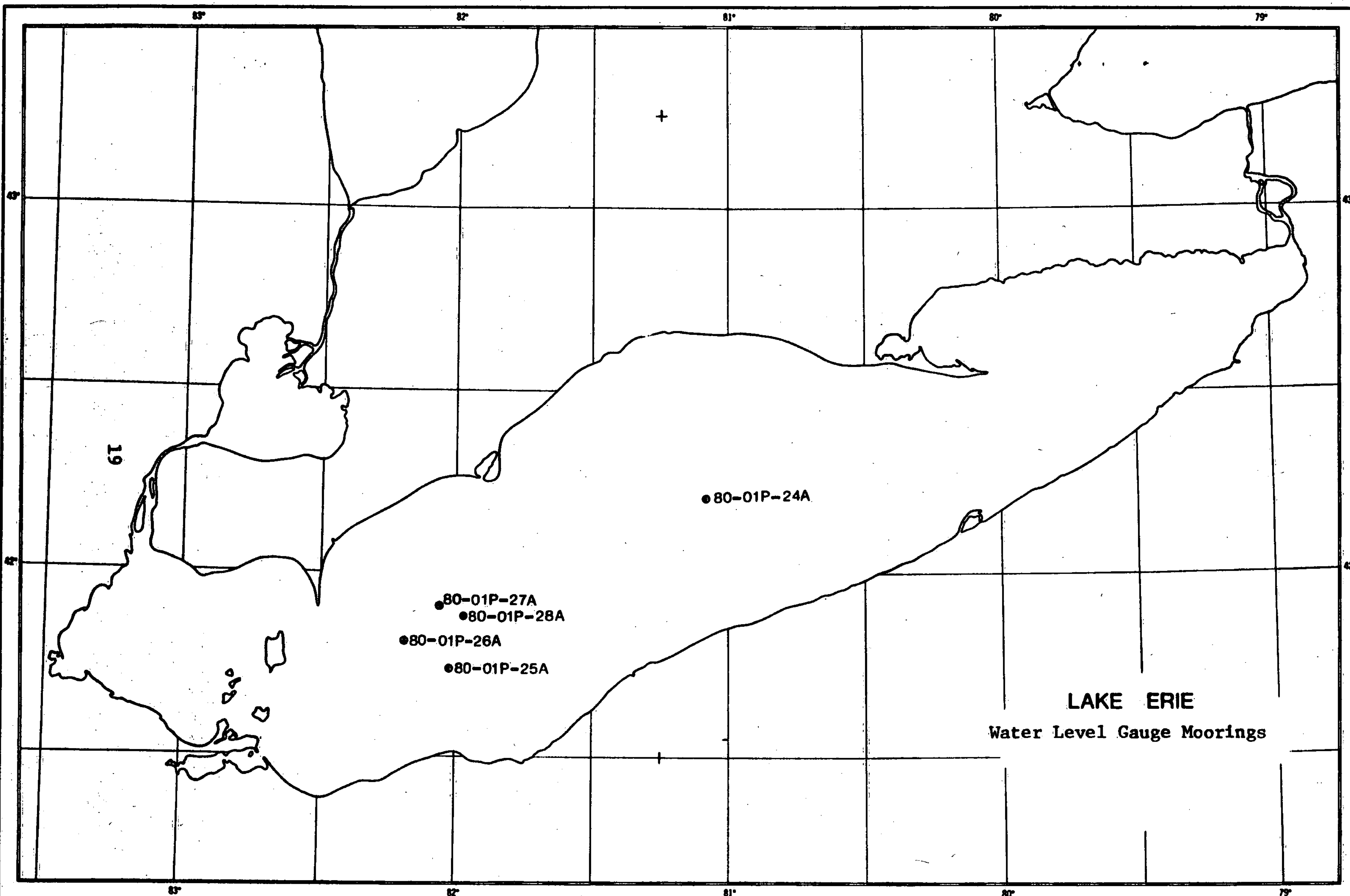
Five tide gauge moorings were installed during the field season both by the LIMNOS and the ADVENT. The moorings were deployed in the usual U-shaped configuration. A piece of plywood (4' x 4') was strapped to the instrument anchor to prevent the railway wheel from sinking. A concrete block (1 cubic ft.) was attached to the instrument line just below the subsurface float to reduce the amount of buoyancy and prevent the mooring from walking. Although these precautions were taken, the railway wheel still stood on end. In future, a much larger weight must be attached under the subsurface float.

WATER LEVEL GAUGE SUMMARY

MOORING NO.	LATITUDE N.	LONGITUDE W.	GAUGE	DEPTH
80-01P-24A	42° 14' 00"	81° 10' 15"	408A	20 m
80-01P-25A	41° 46' 19"	81° 46' 10"	75/524AM	20 m
80-01P-26A	41° 47' 52"	81° 56' 20"	78/708AM	20.5 m
80-01P-27A	41° 56' 03"	81° 53' 32"	76/737AM	21 m
80-01P-28A	41° 53' 38"	81° 43' 48"	77/619AM	23 m

A Aanderaa Gauge

AM Applied Microsystems Gauge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80-01P-27A
80-01P-28A
80-01P-26A
80-01P-25A
LAKE ERIE
Water Level Gauge Moorings

METEOROLOGICAL SYSTEMS

During the 1980 field year, 3 meteorological buoys were deployed in Lake Erie. The buoys were positioned from South of Port Stanley to South of Erieau.

The principal purpose for collection of meteorological data was to obtain estimates of area averages and distributions of the surface fluxes of momentum, heat and water vapour over Lake Erie. The data was used to support the 1980 Lake Erie Physics Program.

Wind speed, wind direction, air temperature, relative humidity, water temperature, buoy orientation and integrated solar radiation were recorded aboard the Met. buoys. The LIMNOS installed and retrieved all Met. buoys and they were monitored whenever possible by the ADVENT.

THE BUOY

The buoys used were Geodyne toroidal type made of fibreglass and foam-filled with an aluminum A-frame mounted on top. Each buoy was equipped with a large wind vane to orient the buoy into the wind. As an aid to navigation, buoys were equipped with a radar reflector and a white flashing Geodyne light.

The LIMNOS launched the buoys in position with two railway wheels (750-lb. each) using 3/4" chain from the anchor to the buoy.

The sensors were mounted onto "quick-release" aluminum arms. All sensors mounted on the arms were 4 metres above the water's surface. The solarimeters were mounted at the top of the A-frame at a height of 3.5 metres above the water. Near surface water temperature sensors were mounted to the outside of the fibreglass "do-nut" a few inches below the water's surface.

The Hymet recorder was installed onto the first level of the A-frame. Two hold-down straps around the Hymet can were locked for security reasons.

Solar radiation integrators were mounted beside the Hymet recorders on two of the buoys--80-01M-01A and 80-01M-03A.

THE RECORDER SYSTEM

Plessey Electronics, Hymet Model MM-1

Recording speed:	4.3 mm/sec.
Medium:	183 m, 6.4 mm magnetic tape
Format:	Digital serial form 10 digit binary number
Storage capacity:	55,000 measurements (each of ten bits)
Recording modes:	1. Automatic (battery-driven clock) 2. External trigger 3. Continuous operation 4. Single sample
Automatic sampling rate:	Adjustable, but set at 10-minute intervals for this application
Temperature range:	-10°C to +40°C

Electrical

Power requirements:	18 volts battery-operated
Input voltage:	0 to 5.120 volts
Input impedance:	2 M ohms per volt - minimum at balance
Recorder accuracy:	± 1 part in 1024
Resolution:	5 mV
Recording time:	8 seconds/channel
Reference voltage for resistive input signal:	5.120 volts ± 3 mV at 20 mA maximum
Signal:	Negative going rectangular pulses of 4 volts amplitude from 11 Kohms source impedance
Duration:	Binary 1 pulse 50 mS, Binary 0 pulse 170 mS

Dimensions and Weights (approximate)

Overall recorder dimensions:	30 cm x 20 cm x 19 cm (14" x 8" x 7 1/2")
Recorder weight:	5.9 Kg. (13 lb.)

THE SENSOR SYSTEM

Wind Speed & Direction

Anemometer:	3-cup (Beckman and Whitley, Model 170-41) cups geared to a single continuous turn potentiometer through a 11,106.46: 1 speed reducer

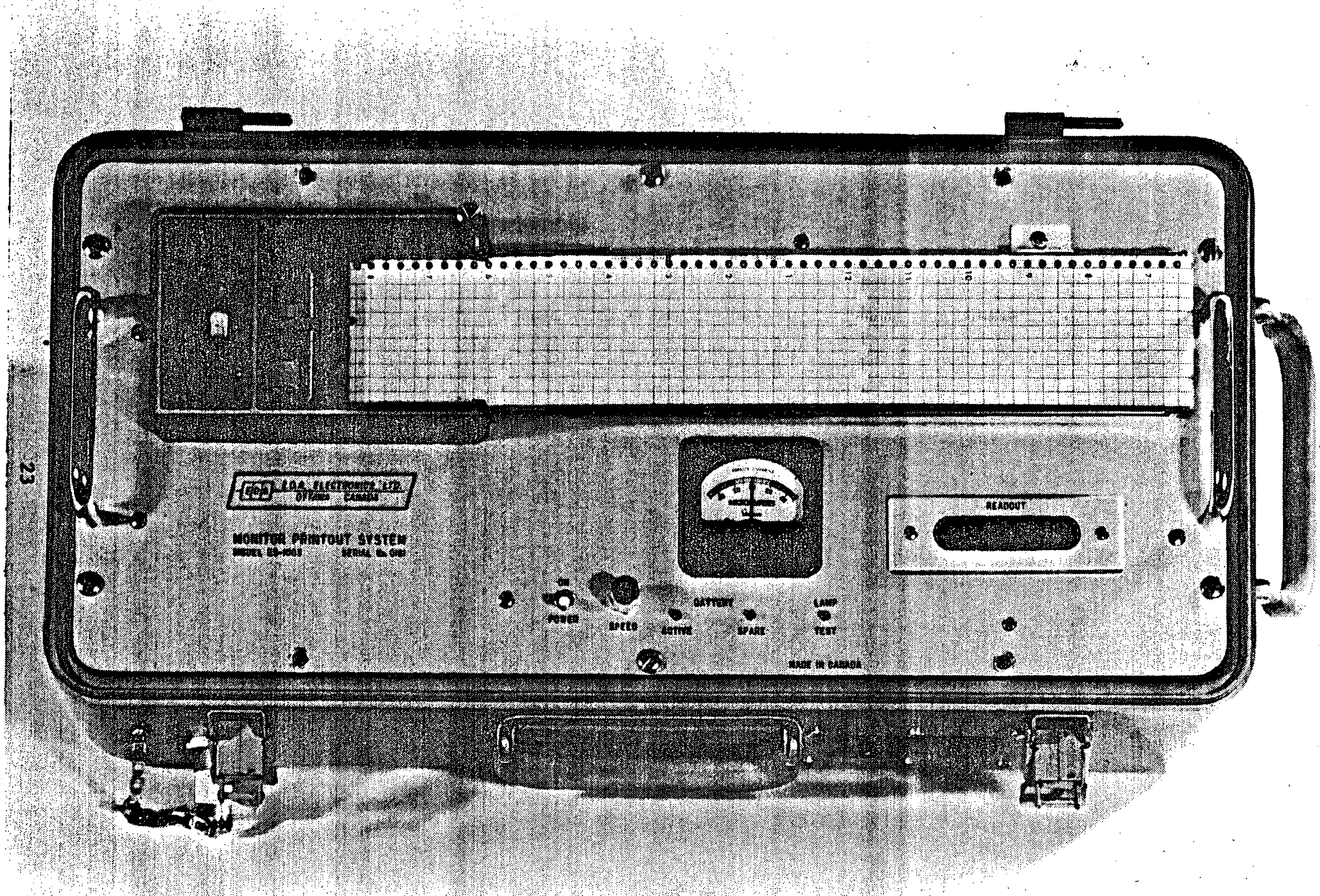
Sampling period:	10 minutes, summation of air passage during sample period
Ambiguity speed:	2680 cm sec^{-1} (60 mph)
Starting/stopping speed:	45 - 89 cm sec^{-1} (1-2 mph)
Distance constant:	130 cm (4.3 ft.)
Accuracy:	$\pm$ 2% above 200 cm sec^{-1}
Static torque at cups:	0.36 gram-cm maximum (0.005 oz-in)
Sensor:	Single, flat plate vane coupled to an oil-damped magnetic compass. Instantaneous position read on command every 10 minutes by solenoid clamping of the compass
Accuracy:	$\pm$ 5°
Dynamic response of vane:	Damping constant of vane 0.4 to 0.5 (estimated)
Hysteresis:	Within limits of accuracy

Relative Humidity

Sensor:	Modified Hugrodynamics, Model 15-7012 W humidity transducer mfrg. specifications
Humidity range (modified):	40 to 99%
Accuracy:	$\pm$ 3T R.H. between 4.5 and 49°C
Time constant:	5.5 minutes
Modifications:	Lithium chloride cells utilized below 40% R.H. are removed. The sensor is enclosed in a water vapor pervious cellulose acetate film to reduce liquid water contact and to prevent contamination by atmospheric-borne salts
Mounting:	Installed within a Thaller type radiation shield

Air Temperature

Sensor:	Yellow Springs Instrument No. 44005 precision thermistor in a copper heat sink
Range:	-10°C to +40°C
Accuracy:	$\pm$ 0.1°C (calibration individually checked)
Time constant:	Approximately 30 sec. without radiation sheilding
Exposure:	Mounted in a naturally aspirated Thaller type radiation shield



MONITOR PRINTOUT UNIT

Water Temperature

Sensor:	Yellow Springs Instrument No. 44030 precision thermistor installed in a 2.5 cm dia. x 15 cm plexiglass housing
Range:	-2 to +35°C
Accuracy:	±0.1°C (individual calibration)
Time constant:	Approximately 5 minutes

MONITORS AND CHANGEOVERS

Monitors of the Hymet systems were made at two-week intervals whenever possible (see page 23). The monitor procedure follows:

1. ADVENT tied up to the buoy taking care not to damage the water temperature sensor
2. The monitor printout unit (MPU) was plugged into the Hymet recorder on the buoy
3. The time was checked using a time signal receiver
4. The readings were recorded into a field notebook when the Hymet recorder fired at ten-minute intervals. Readings were taken for two consecutive cycles
5. The readings were converted to real meteorological values using conversion tables
6. Readings were taken onboard the ADVENT using a hand-held anenometer, compass, motorized psychrometer and a water temperature bucket to double-check values from the buoy
7. Sensors were changed if required
8. The solarimeter was cleaned
9. The paper in the solar radiation integrator was checked and changed if required
10. The Geodyne light was checked

LAKE ERIE METEOROLOGICAL POSITIONS

MOORING NO.	LATITUDE N.	LONGITUDE W.
80-01M-01A	41° 50' 30"	81° 50' 31"
80-01M-02A	42° 09' 27"	82° 03' 41"
80-01M-03A	42° 13' 42"	81° 10' 26"

LAKE ERIE PERCENT DATA RETURN

The average return of all three Met. stations installed in Lake Erie during the 1980 field season was 83%.

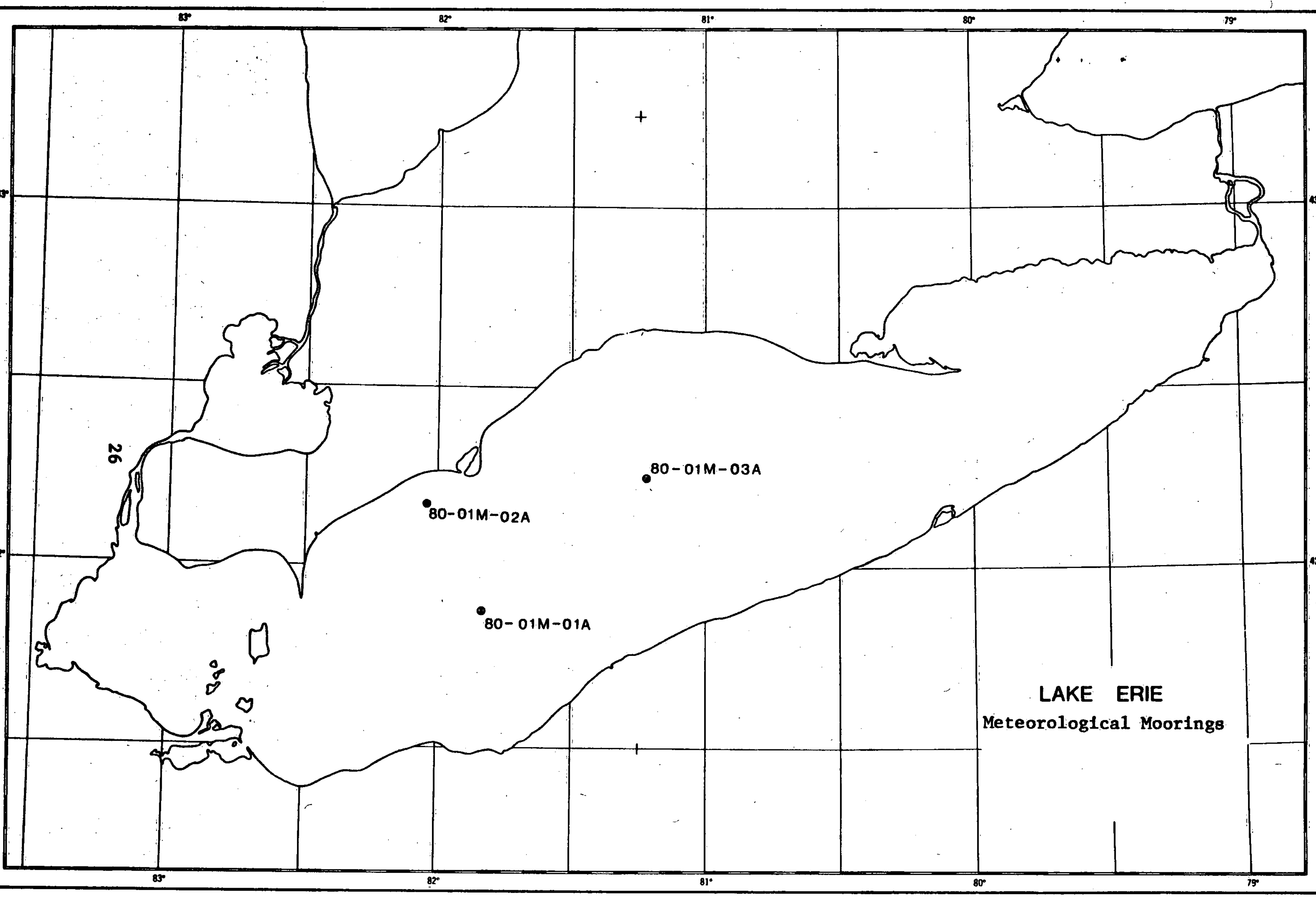
Seven days of data were lost from Mooring 80-01M-03A when the recorder failed towards the end of the project.

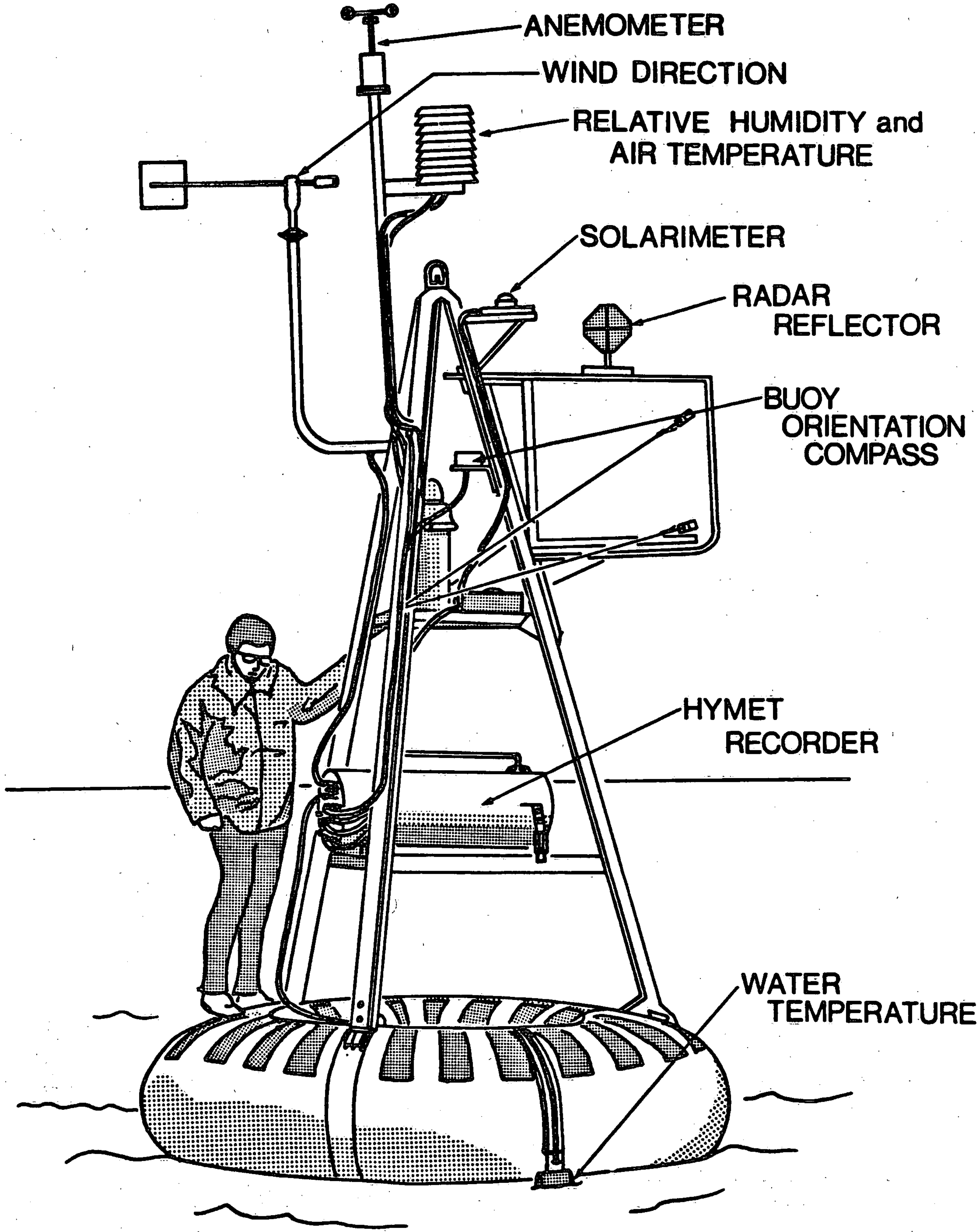
Mooring No. 80-01M-01A
Total possible observations = 24,116
Observations recorded = 15,918
% data return = 67%

Mooring No. 80-01M-02A
Total possible observations = 36,552
Observations recorded = 36,552
% data return = 100%

Mooring No. 80-01M-03A
Total possible observations = 36,288
Observations recorded = 29,544
% data return = 81%

Average % return of all 3 moorings = 83%


83°
82°
81°
80°
79°
43°
42°
80-01M-03A
80-01M-02A
80-01M-01A
LAKE ERIE
Meteorological Moorings



METEOROLOGICAL BUOY

FIXED TEMPERATURE PROFILE SYSTEMS

Four Fixed Temperature Profile (FTP) moorings were installed in Lake Erie during the 1980 field year. The data from the FTP moorings will serve to determine the slope of the thermocline and thence the internal pressure gradients.

The moorings were installed by the LIMNOS, adjusted for depth and serviced by the ADVENT. The Loran C Navigation System was used to position and locate the FTP moorings during the field season. The LIMNOS retrieved all FTP moorings at the conclusion of the field season.

THE BUOY

The FTP buoys used in Lake Erie (1980) were designed by the Mechanical Engineering Unit, CCIW. The buoy is 2.44 metres (8 ft.) in height and 0.48 metres wide. A protection/lifting ring was welded around the top of the buoy. The buoy is constructed of welded aluminum and filled with closed-cell polyurethane foam (density: 0.04 gms/cm^3). Through the centre of the buoy runs a hollow tube which houses the Geodyne digitizer. Four clamps mounted around the top of the buoy lock down onto the digitizer to hold it in place. Guides mounted on the side of the buoy protect the cable. The top two thermistors of the FTP cable were located at the side of the buoy. These thermistors were covered with radiation shields to block them from direct solar radiation.

The buoy was painted with red and yellow vertical stripes above the water line two feet below the top of the buoy. Below the waterline, the buoy was painted with anti-fouling paint. Prior to launching, the buoy was equipped with a radar reflector and a white quick-flashing light.

INSTRUMENT SPECIFICATIONS

Fixed Temperature Profiler, CCIW

Recording System: Geodyne type 775-25 resistance digitizer

Parameters Recorded: temperature, timeword, reference word

Recording Medium: 120 metres (390 ft.) endless loop tape, 6.35 mm (1/4 inch), 2 track, 4.8 megabits, 512 BPI at 64 bits/second

Word Size: 16 bits, 12 used for sensors, 14 for timeword

Tape Capacity: 180,000 words (10^4 scans)

Clock Accuracy: ±10 sec/day cumulative (maximum)

Sensor Type: Fenwal K2284 Thermistors

Time Constant: 4 minutes ±20%

No. of Sensors: 18 or 21

System Temperature Accuracy: ±0.030°C

Temperature Range: 0°C to 30°C

Sensor Depths: Surface to bottom, spacing as required

System Depth Accuracy: ± 0.2 metres

Mooring Type: taut

Component Weights: (approximate)

Complete digitizer	50 kg
Buoy	118 kg
Cable	180 kg

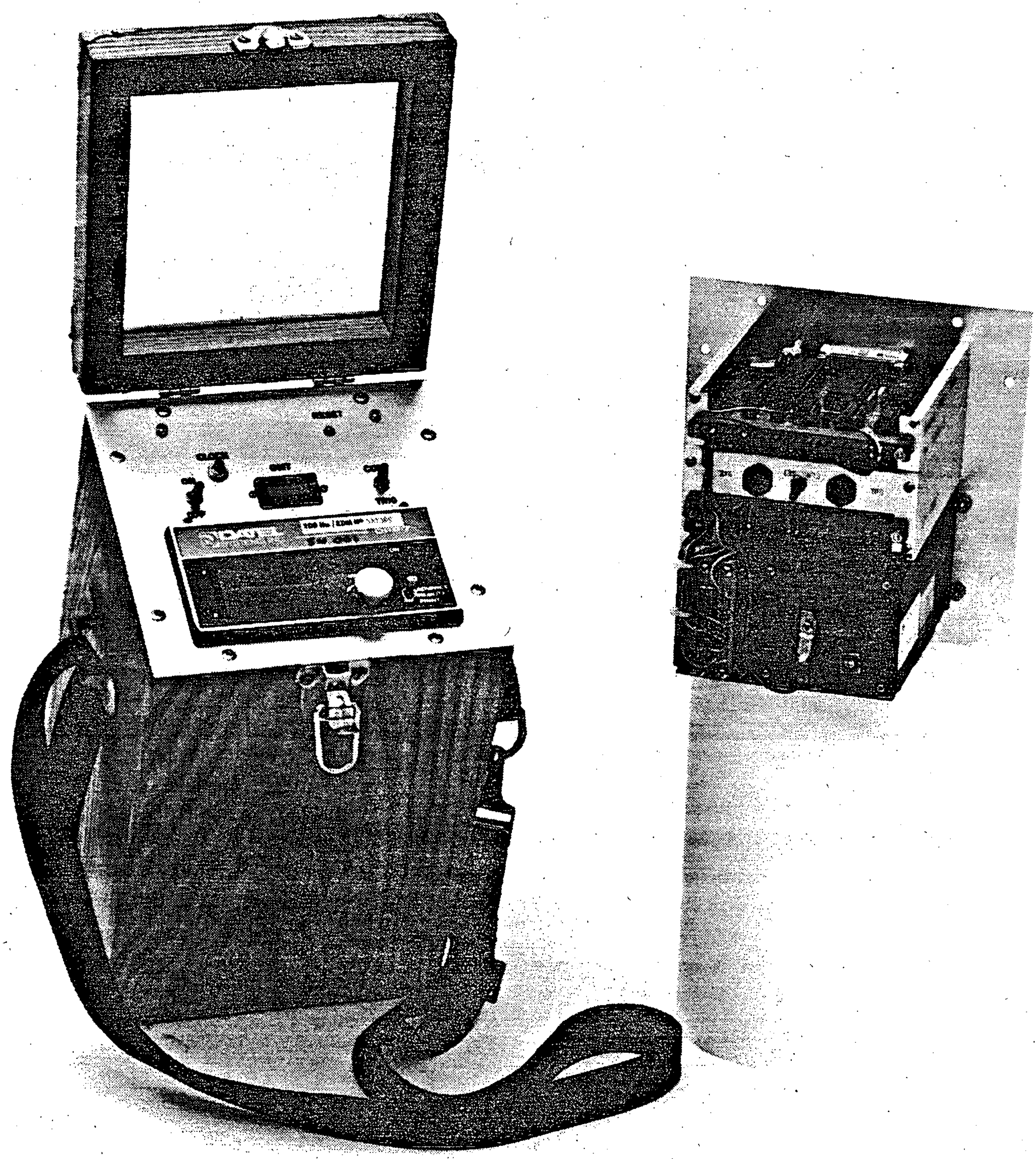
MONITORS AND CHANGEOVERS

FTP systems were monitored on a two-week schedule as weather conditions permitted.

Monitors were taken from a Boston Whaler to reduce the possibility of excess strain on the FTP cable resulting from lifting the FTP buoy. Due to the taut-line type of installation, monitors could be taken only in sea states of two feet or less. Larger waves resulted in the buoy submerging as the wave crest passed. The new Geodyne digitizer and current meter monitor MKII was used to monitor the digitizer and FTP cable. A total of twenty-four readings were taken including a reference number and time. Twenty-one readings (decimal numbers) were converted to real temperature values and compared to EBT values.

GEODYNE DIGITIZER AND CURRENT METER MONITOR MKII

The monitor box for Geodyne systems as supplied by the manufacturer proved unsatisfactory for field use, especially when monitoring had to be done from a small launch in the lake. To overcome the difficulty experienced by field staff, it was decided to



FTP MONITOR

build an in-house-designed monitor microprocessor-controlled with a printer to give a hard copy read-out of all channels.

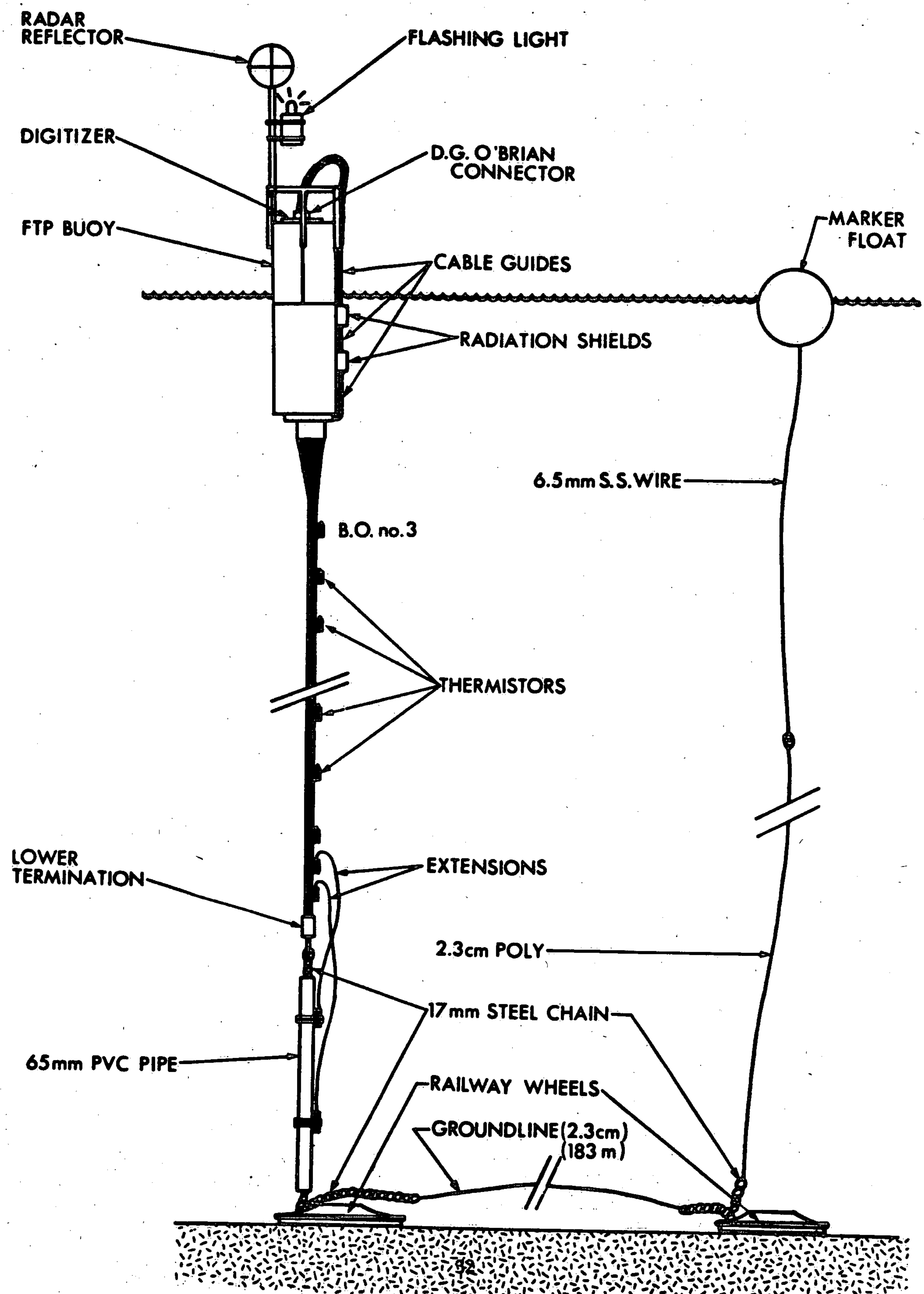
The system consists of an 8085 Intel microprocessor single board microprocessor card sea-data-RD85 with Eprom 2716 programmed to monitor both digitizers and current meters, a front-end signal interface card and a Datel DDP-7 printer. A LCD four digit clock with its independent power source was added to give a visual display of time.

The complete system was housed in a wooden case 32.5 cm x 17.5 cm x 17.5 cm weighing 28.5 kg.

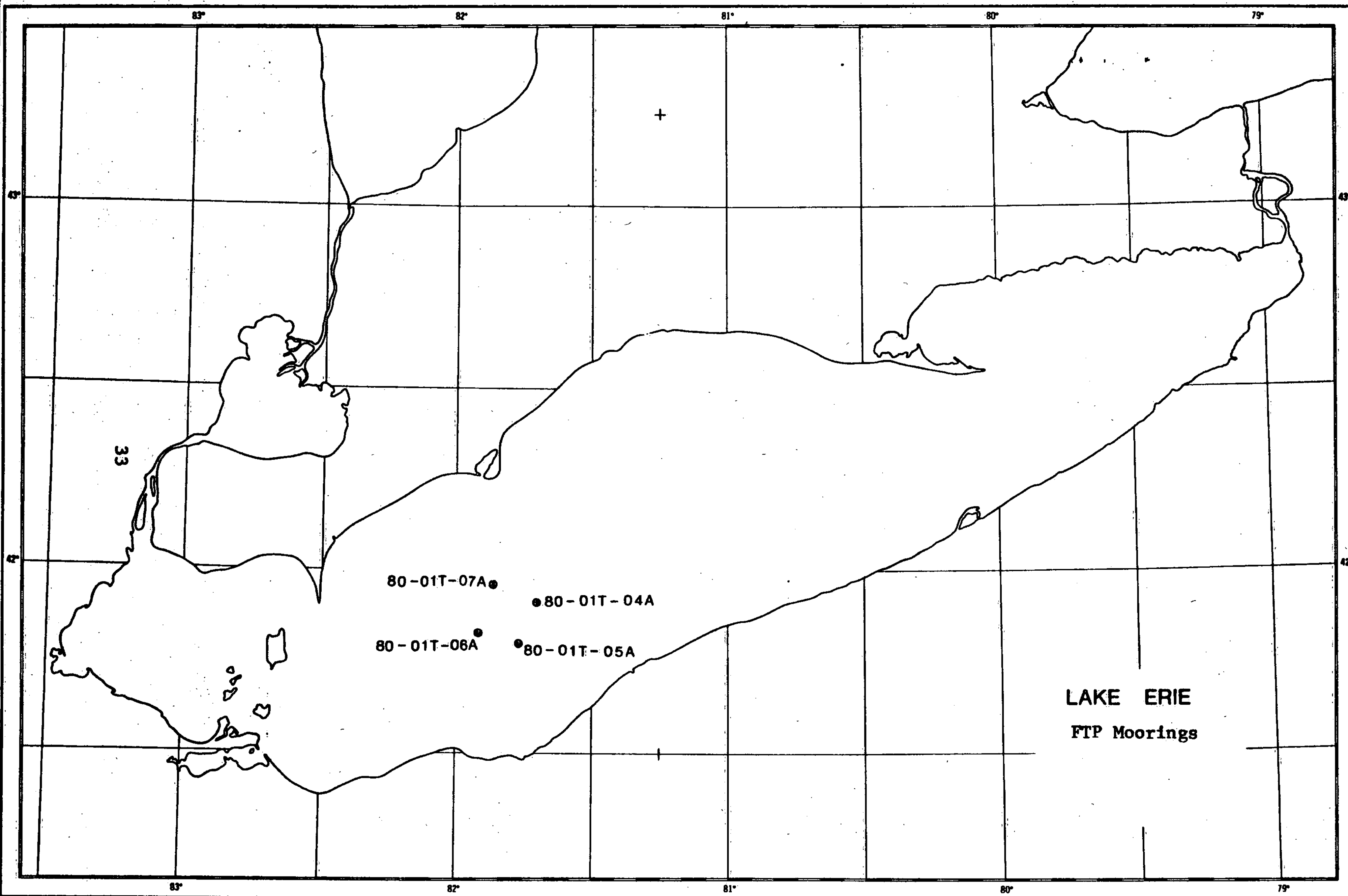
Field use of the system was beyond expectations!

FTP POSITIONS, 1980

MOORING NO.	LATITUDE N.	LONGITUDE W.
80-01T-04A	41° 53' 23"	81° 44' 03"
80-01T-05A	41° 45' 56"	81° 46' 51"
80-01T-06A	41° 47' 55"	81° 56' 41"
80-01T-07A	41° 55' 33"	81° 53' 49"



FIXED TEMPERATURE PROFILE (FTP) MOORING


LAKE ERIE
FTP Moorings
80-01T-07A
80-01T-04A
80-01T-06A
80-01T-05A
83°
82°
81°
80°
79°
43°
42°

ANCHOR STATION EXPERIMENTS

There was only one anchor station experiment conducted during the 1980 field season. This experiment was carried out between August 11 - 22. During that two-week interval, the ship was at anchor for a 10-day period.

Upon arrival at the anchor station, several scientific instruments had to be installed. Installation involved the M-CATS, wave rider, tide gauge mooring, oxygen demand chamber (Dr. Snodgrass, McMaster University) and deployment of drogues.

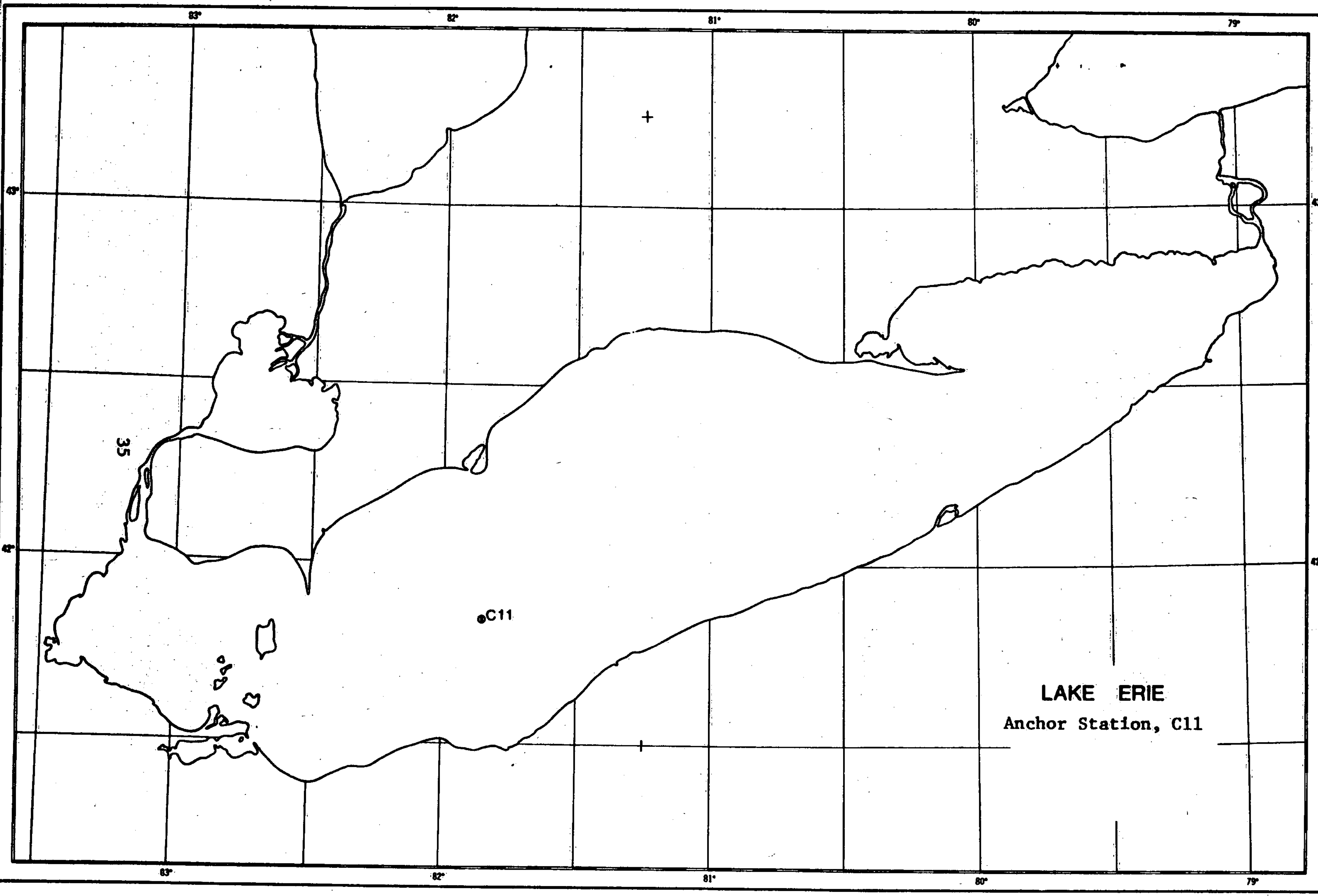
DESCRIPTION OF M-CATS

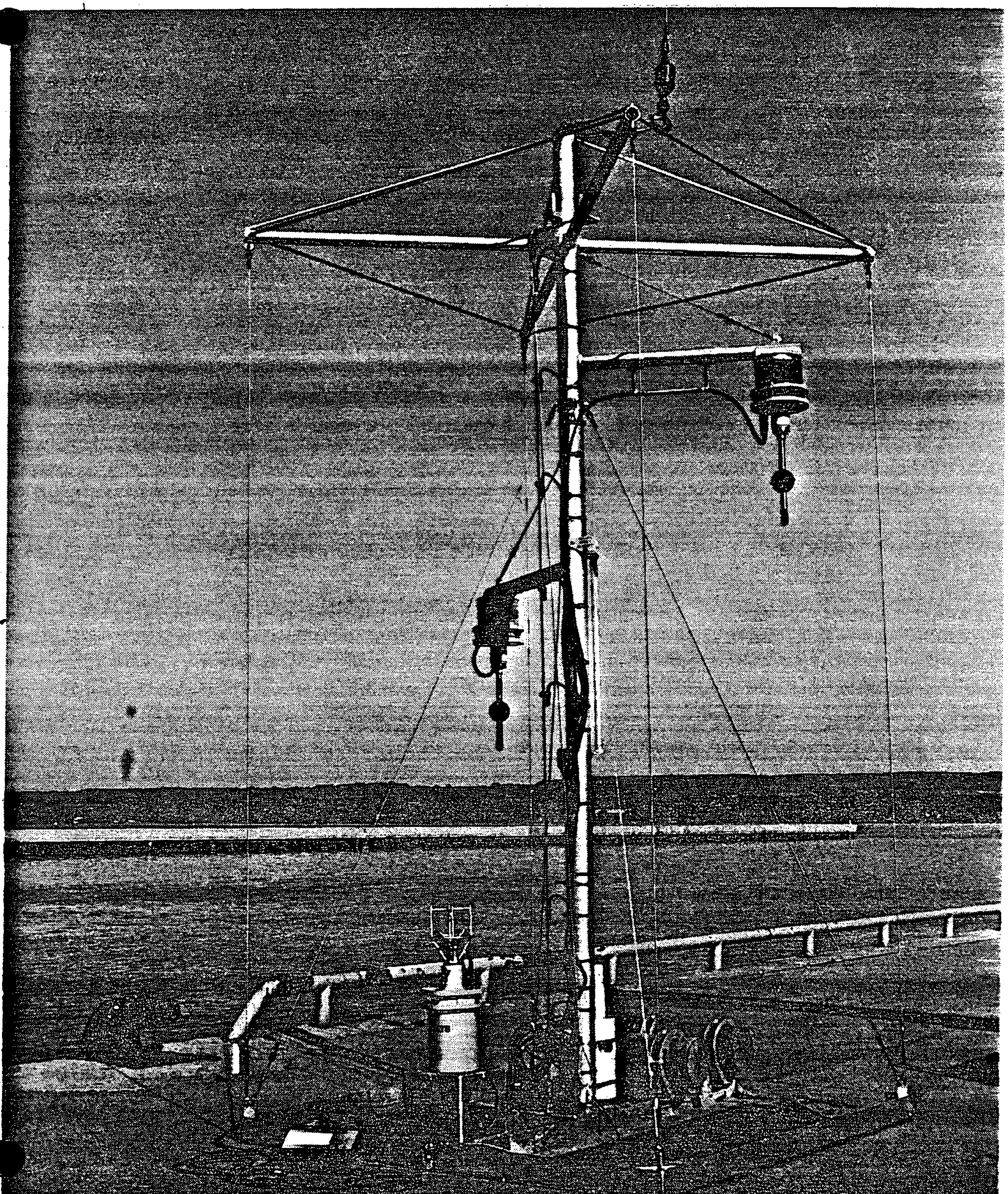
M-CATS is a bottom-mounted current and temperature measurement system. It consists of an array of three two-axis water current sensors and eight thermistors cabled to a digital data-logger and system battery. The system is specially designed to measure the characteristics of near bottom processes over a period of up to ten days. The sensors are sampled every 16 seconds by the data logger. Currents are measured 1, 2 and 3 metres off bottom. Thermistor placement is variable.

The two uppermost current sensors are electromagnetic current sensors, Marsh McBirney Model 518. The lowest current sensor is a CMI acoustic current sensor. The thermistor array consists of eight 4 kilo-ohm iso-curve thermistors. Five of the eight five-second time constant thermistors were coated with red nail polish to increase the time constant to 16 seconds. Three of the original eight are 0.1 second time constant ("X-type") thermistors coated with silver nail polish to increase the time constant to 16 seconds. The thermistor and current sensor cabling was moulded from 7-conductor shielded cable.

M-CATS INSTALLATION AND RETRIEVAL

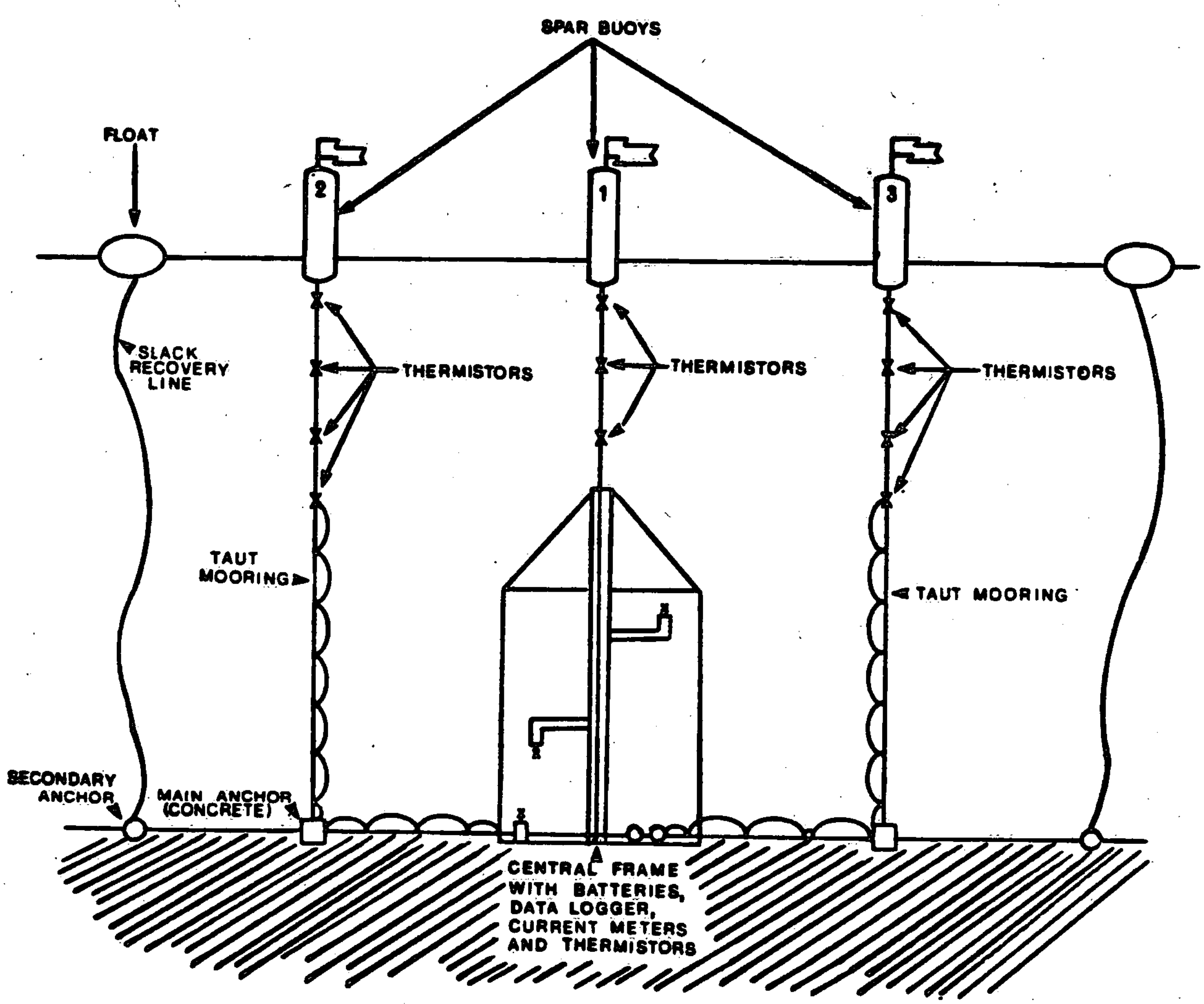
The instrument was installed by using a standard single point mooring procedure; that is: a 2.5 cm braided rope attached to the


83°
82°
81°
80°
79°
43°
42°
C11
LAKE ERIE
Anchor Station, C11



M–CATS

M-C.A.T.S. SYSTEM
WITH
OUTRIGGER THERMISTOR ARRAYS



lifting eye on the M-CATS. This rope was then fed through a McKissick trawl block which was attached to the boom of the vessel's crane. The crane was then utilized in the positioning of the system. The rope was again fed through another block which was secured to the ship's bollards permitting a proper lead to the ship's capstan. The system was then launched or retrieved under complete control by movement of the capstan.

A zero speed check of the system was carried out over the side of the vessel immediately before installation or retrieval.

WAVE RIDER MOORING

A wave rider mooring was deployed a short distance from the final anchored position of the vessel at the beginning of the experiment. This mooring was installed with a U-shaped configuration which made retrieval simple and safe.

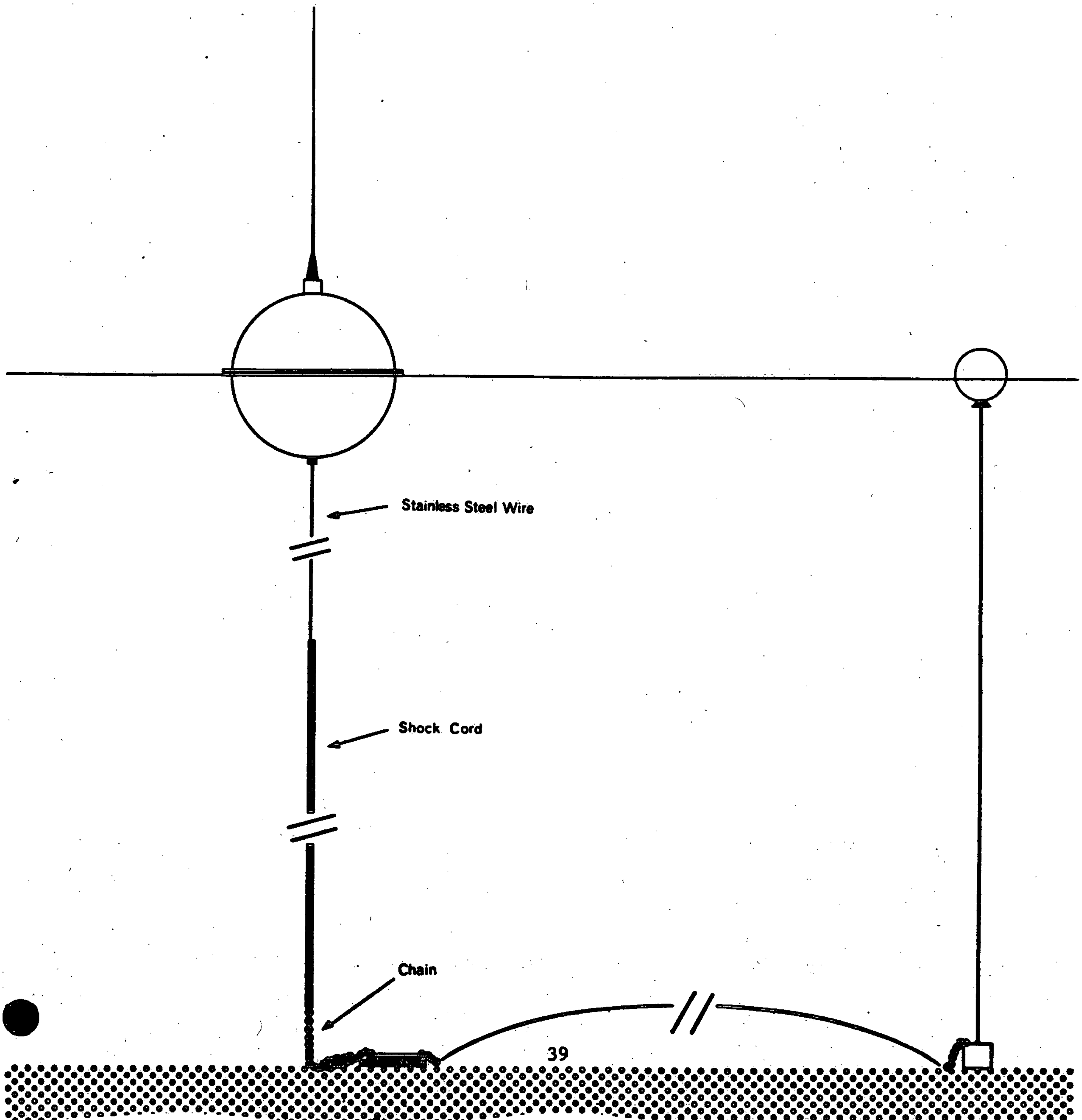
The receiver for this system was carried onboard the LIMNOS. The system was systematically monitored and serviced by technical staff onboard.

DROGUES

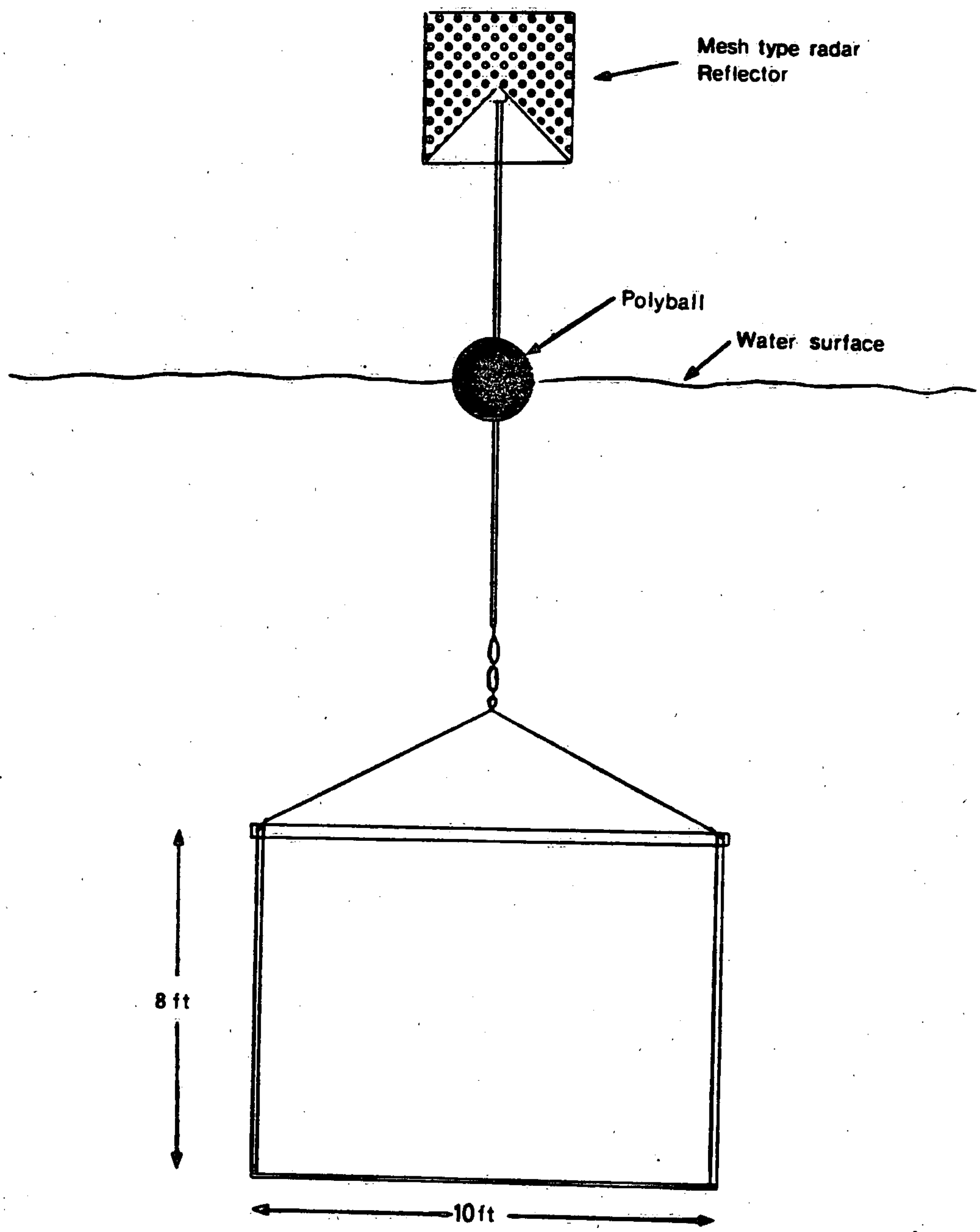
During the early part of 1980, a new "roller blind" drogue was developed. Although they were the same shape as the previously designed drogues, they had a much larger surface area and were less susceptible to wind drift. The drogue sail this season was an 8' x 10' piece of plasticized canvas (a commercially bought tarpaulin). A 1/2" reinforcing rod was fed through the bottom seam of the canvas for weight to hold the sail open. The top of the sail was held rigid by wrapping the canvas around a 1" aluminum conduit. It was held in place by forcing a split 1 1/2" plastic pipe over the canvas and the conduit.

The drogues were set into position by either deploying them from a Boston Whaler or releasing them from the moving ship. The movements of the drogues were tracked by the ship's radar from the anchored position. To ensure correct identification of each drogue, the Boston Whaler was used to verify the targets once a day. Retrieval was always done by Boston Whaler.

Wave Rider Mooring



DROGUE CONFIGURATION



THERMISTOR ARRAY

Temperature measurements were collected from the vessel by two methods: thermistor array and EBT.

A string of 12 thermistors and one pressure transducer were lashed together into one thermistor cable and then suspended over the stern section of the ship. This homemade thermistor array was connected to an accumulator used to dampen the motion caused by wave action on the vessel. A dampening plate was incorporated into the thermistor cable to increase drag on the cable in order that the accumulator could operate efficiently. The thermistor outputs were recorded at 2-second intervals on magnetic tape in the ship's laboratory. This system proved to be very successful and reliable throughout the entire anchor station experiment.

ELECTROBATHYTHERMOGRAPH (EBT)

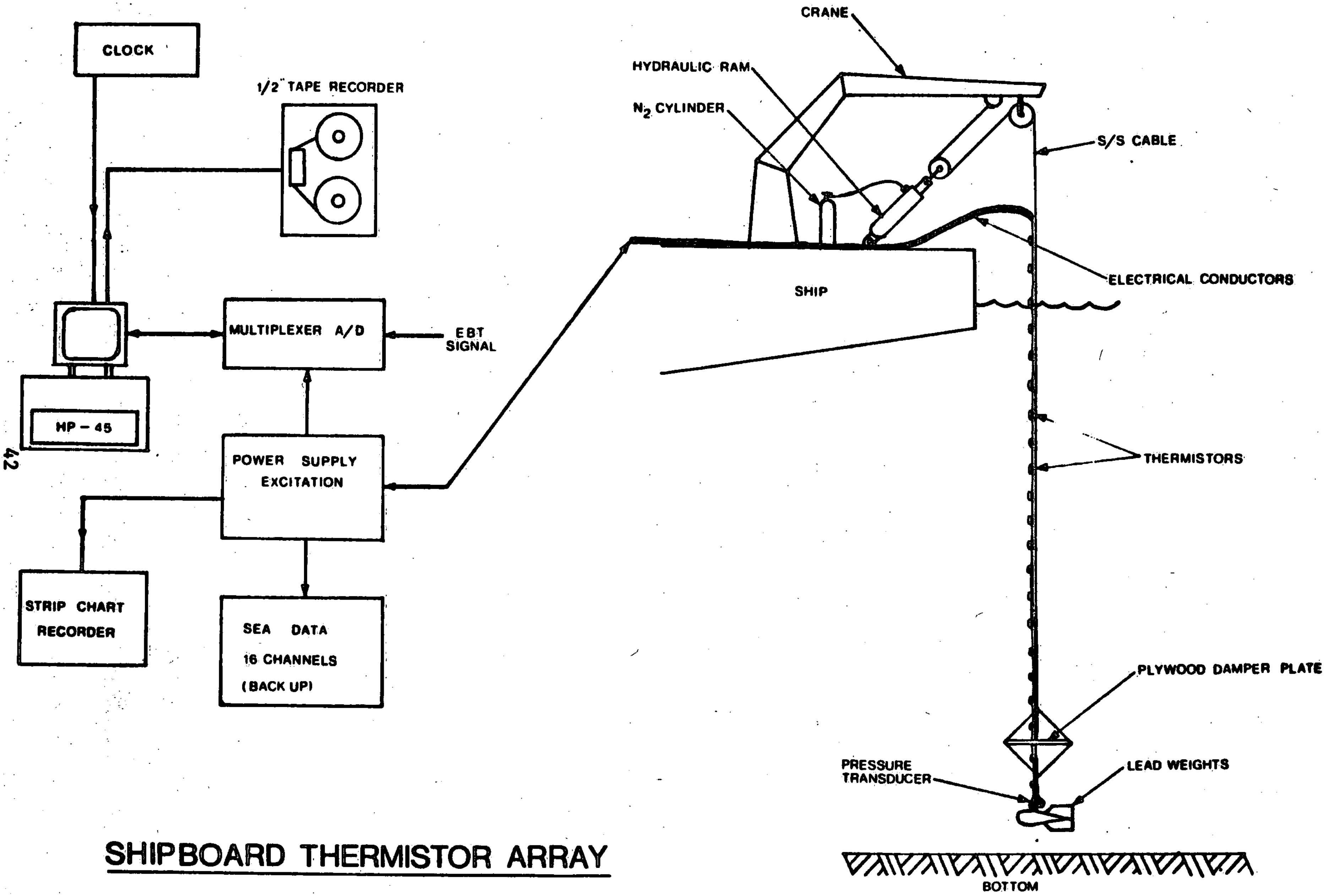
Vertical profiles of temperature were taken with the ship's EBT system at 20-minute intervals. All profiles were recorded in digital form along with data from the thermistor array on the magnetic tape. Every third (hourly) profile was also recorded on an X-Y plotter. A surface bucket thermometer observation was collected to verify the operation of the EBT system. Whenever weather conditions permitted, the EBT sensor was suspended at the surface of the water so that a continuous surface temperature could be recorded onto the magnetic tape.

WATER SAMPLING

During the anchor station, the rosette water sampler or Van Dorn bottles were used to obtain water samples. Sample depths varied with the time of day as described below:

Sample depths at 0000, 0400, 0800, 1200, 1600 and 2000 hours were: 1 metre, 2 1/2 metres and every 2 1/2 metres thereafter 'till bottom -1 metre. These depths sampled were for oxygen only.

Sampling depths also at 0000, 0400 and 1600 hours were collected from the bottom of the epilimnion, mid-thermocline and top of hypolimnion. Sampling depths also at 0800, 1200 and 2000 hours were: 1 m, bottom of epilimnion, mid-thermocline, top of hypolimnion and bottom -1 metre.



SHIPBOARD THERMISTOR ARRAY

These depths were sampled for: POC, alkalinity, dissolved organic carbon, total P (filtered and unfiltered), soluble reactive phosphorus, nitrogen, total particulates, ammonia, nitrate and nitrite, silicate and chlorophyll a.

OPTICAL MEASUREMENTS

Every hour, a transmissometer profile (0.25 metre path length) to bottom was obtained using the multi-band transmissometer and the .45 Wratten filter. At least three times daily, the other four filters were used for intercomparisons of the five filters. Secchi discs were also obtained at hourly intervals.

Quantum Photometers were also collected hourly from 0800 until 1800 hours daily to within 2 metres of the bottom.

METEOROLOGICAL OBSERVATIONS

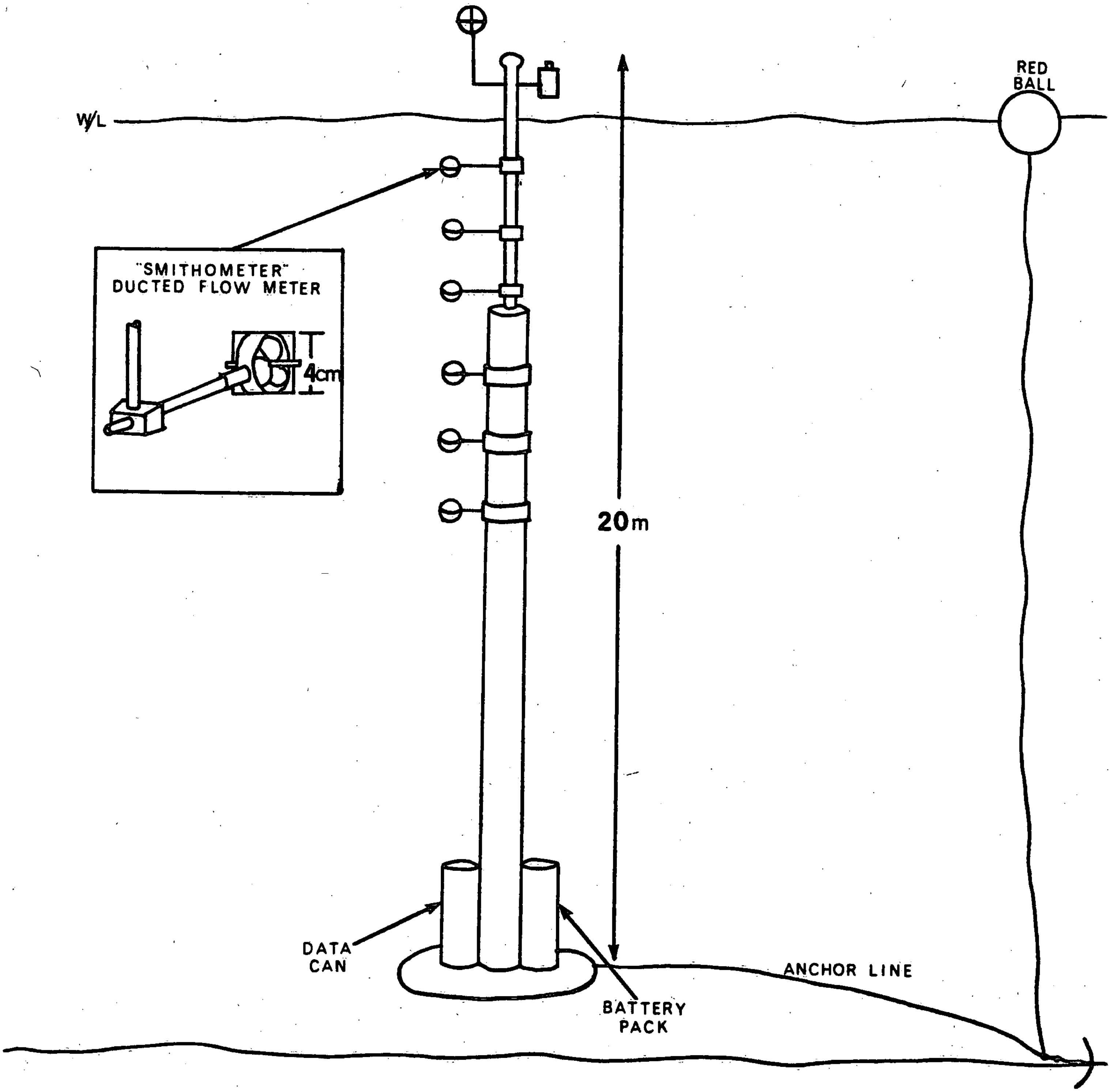
During the entire cruise, at three-hour intervals, a complete surface meteorological observation was completed. Also, during the anchor station, an hourly minor meteorological observation was compiled.

AESOPS BUOY

The buoy consists of three buoyant sections totalling 20 m in length. These are easily assembled and dismantled and may be varied in number to alter the buoy's overall length, draft and payload. Attached to the bottom buoyant section is a dampening plate approximately 2 metres in diameter. Also attached to the bottom buoyant section are two metal canisters which contain the data logger and battery pack.

The buoy, when deployed, stands vertically in the water with only the top 1/2 metre protruding above the water surface.

Deployment of the buoy was carried out by using both ships' cranes with ropes leading from the base and the mid-point of the upper buoyancy section. The buoy was placed overside of the ship in a horizontal position. The rope on the base was slowly lowered while the rope on the top section was made fast. When the buoy came into a vertical position, the second rope was lowered until the buoy sank to its proper depth. The buoy was then allowed to drift away from the ship.


W/L
RED BALL
"SMITHOMETER" DUCTED FLOW METER
4cm
20m
DATA CAN
ANCHOR LINE
BATTERY PACK

AESOPS BUOY

The ship's whaler was then deployed to tow the buoy into position using the rope which was attached to the base. When in position, an anchor was attached to the baseline and lowered to bottom. The buoy was left in position for 12 hours then retrieved to change the data logger and batteries.

AANDERAA CURRENT METERS USED IN A PROFILING MODE

Two Aanderaa current meters were employed to establish a crude estimate of the profile of velocity shear over a vertical segment of the water column.

The first current meter, the reference meter, was suspended from a hydrographic wire at the desired depth, approximately 1 metre above bottom. The second meter, the profiling meter, was fitted so as to slide down the hydrographic wire. It ballasted to a small negative buoyancy so that its sinking rate was about 5 cm/sec. Both current meters were operated at their maximum sampling rate (two samples per minute). The profiling meter was released from the surface and sunk toward the bottom meter. At the rapid sampling rate, the shear profile was integrated over 3-metre vertical segments.

The ON/OFF switch was routed through the external sensor plug (Inter Oceanics connector) so that the instruments could be stopped and started by the removal and insertion of a plug.

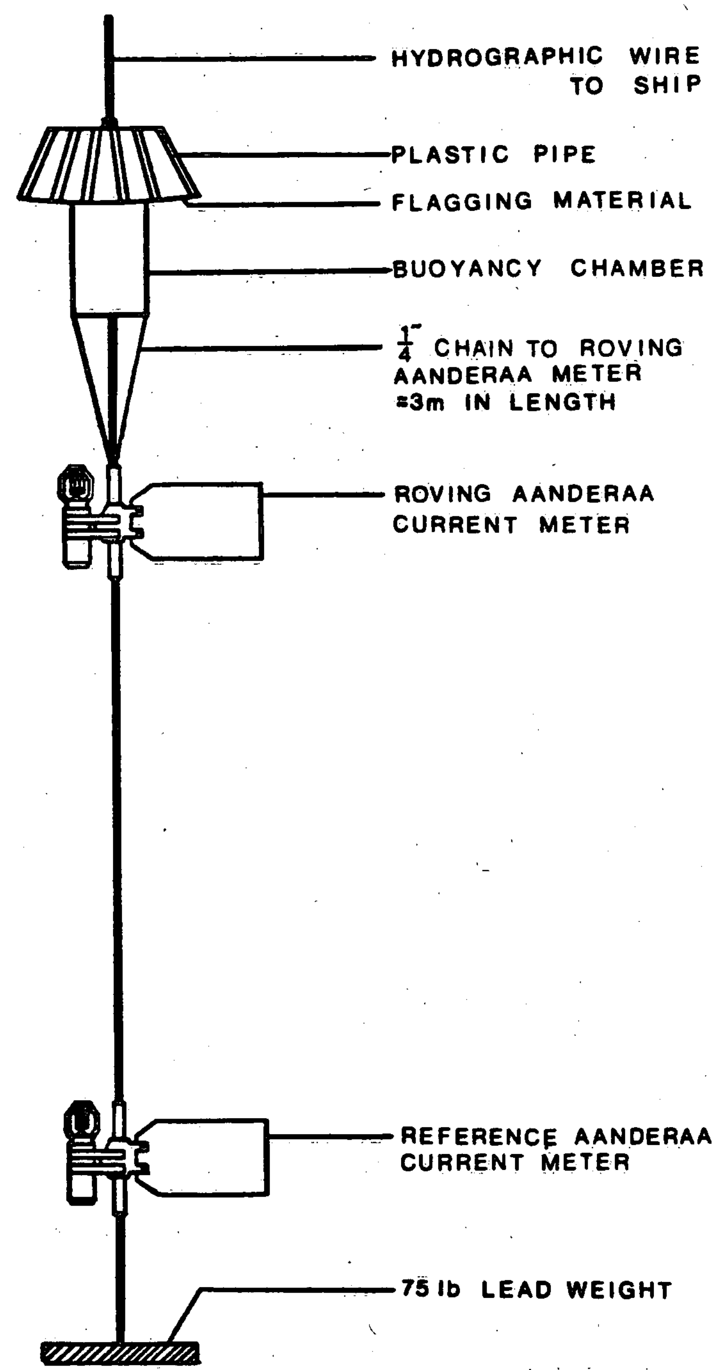
The sinking meter was effectively uncoupled from the ship, suspended below a parachute drogue designed especially for the experiment. Once the drogue was a few metres below the water surface, it was not influenced by surface waves and gave a relatively good current profile.

At a sinking rate of 4 - 5 cm/sec., it took close to 20 minutes for the profiling meter to sink through the 23 metres of water column.

Before and after a profile, monitors were collected from both Aanderaa meters as well as an accurate time. This was done to ensure proper data comparisons.

VAPS

The VAPS (Vertical Automatic Profiling System) was anchored close to Station C11 on 19th August. The deployment was conducted in a four-step procedure taking approximately two hours.



AANDERAA CURRENT METER PROFILING SYSTEM

Step one consisted of allowing the VAPS buoy (sailboat) to slowly be hauled upwind by a whaler from the large pontoon barge equipped with lifting A-frame and winch. After the complete anchor cable had been payed out, the double railway wheel anchor was slowly lowered to bottom as part of step two. A 1/4" stainless steel wire was then taken out at right angles to the VAPS anchor wire and anchored in a taut configuration with a 1/2 cubic ft. concrete block. This block was marked with a red inflatable ball. Step three was to slowly back the barge downwind and pay out the signal cable. After having completed step three, the final, most delicate part of the entire exercise began.

The VAPS winch was slowly lowered into the lake until it was just under the surface. The VAPS body itself was then floated into position over the winch and the two were connected ensuring that no water was splashed into the electrical connectors. As soon as the connections were made, the VAPS winch and body were slowly lowered to bottom and released. A second 1/4" wire was then run from the winch to a second concrete block approximately 100 - 150 feet away. Again, this second block was marked with a red inflatable ball. The installation was completed. All attention again turned to the VAPS buoy as the instrumentation was turned on. All systems proved to be working. After several delays in the VAPS arriving on site, several very interesting intercomparison studies were made with the other instrumentation on or near the anchor station.

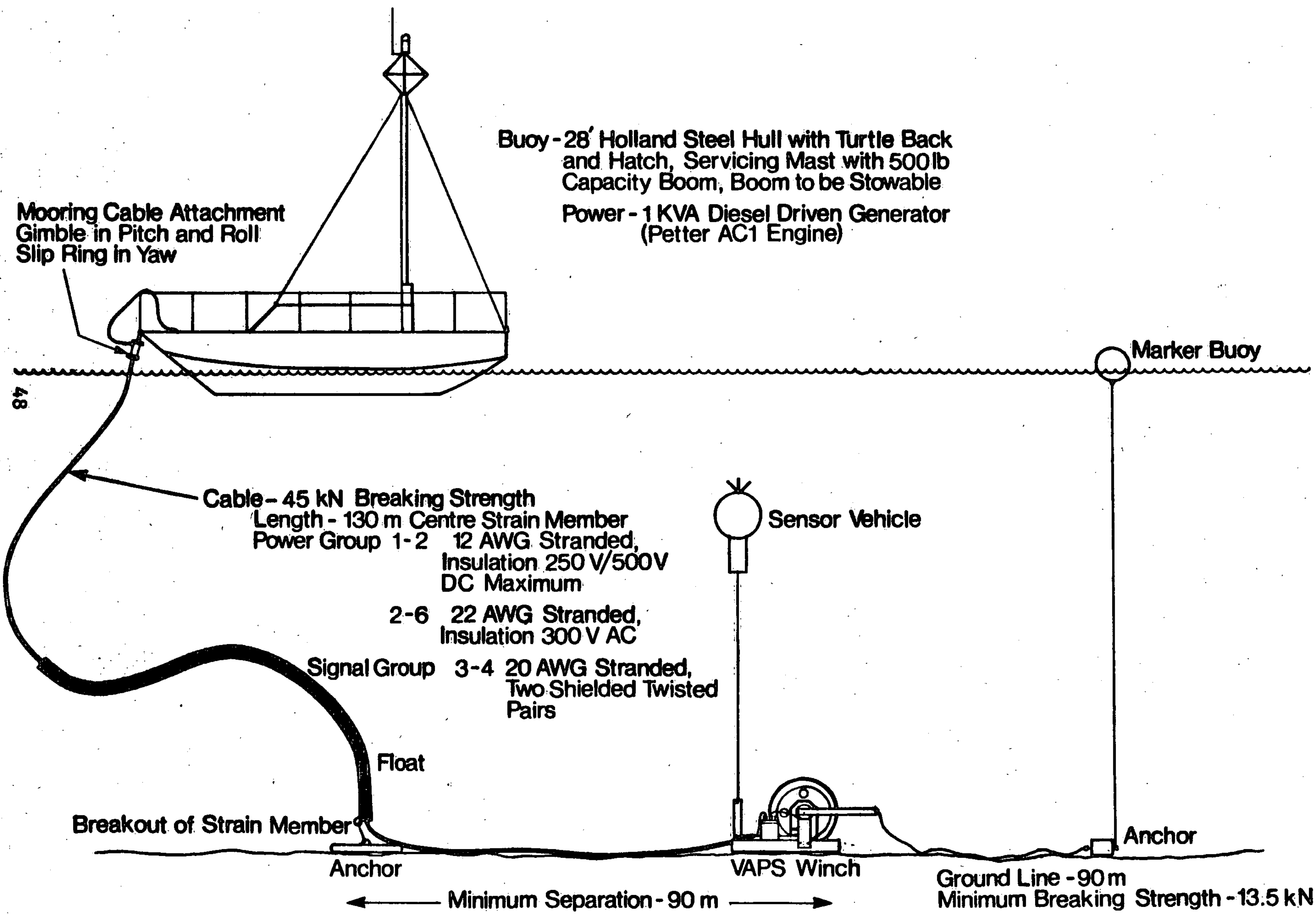
After four days of successful data collection, the signal cable from the anchor to the VAPS buoy failed, terminating the experiment on August 23rd.

The system was retrieved by the CSS ADVENT on September 3.

General Description

The purpose of G-VAPS is to collect synoptic data on physical parameters of lakes by profiling depth at a fixed location. The system is intended for unattended automatic operation with only infrequent visits from field personnel to conduct experiments and change data cassettes. A primary feature is the ability to operate for durations up to 60 days independent of shore. The design depth capability of the system is 200 m. The system is configured for application to 20 m depths with a 130 m long mooring/signal cable.

VAPS


Buoy - 28' Holland Steel Hull with Turtle Back and Hatch, Servicing Mast with 500 lb Capacity Boom, Boom to be Stowable
Power - 1 KVA Diesel Driven Generator (Petter AC1 Engine)
Mooring Cable Attachment
Gimble in Pitch and Roll
Slip Ring in Yaw
Marker Buoy
Cable - 45 kN Breaking Strength
Length - 130 m Centre Strain Member
Power Group 1-2 12 AWG Stranded, Insulation 250 V/500 V DC Maximum
2-6 22 AWG Stranded, Insulation 300 V AC
Signal Group 3-4 20 AWG Stranded, Two Shielded Twisted Pairs
Sensor Vehicle
Float
Breakout of Strain Member
Anchor
VAPS Winch
Anchor
Ground Line - 90 m
Minimum Breaking Strength - 13.5 kN
Minimum Separation - 90 m

The G-VAPS comprises the following major items:

Power/Monitor Buoy

Mooring/Signal Cable

Winch

Sensor Vehicle

The Power/Monitor Buoy is an extensively modified 8.5 m double chine steel sailboat hull, containing a 1.5 kW diesel electric plant, a 60-day fuel supply, winch control and data monitor consoles. In addition, the buoy carries auxilliary safety systems such as navigation marker lights, deck and interior lighting and power distribution, fire suppression equipment and explosive mixture detectors.

The Mooring/Signal Cable for the 1980 season was a rubber-jacketed, 22 conductor cable around a central wire rope core. It is approximately 130 m in length with a distance of 90 m from anchor point to winch connection (along the bottom) and 40 m from anchor point to Power/Monitor Buoy connection. This allows mooring in a 20 m depth with a cable scope of 2 to 1. To prevent cable hockling and tangle when the mooring is slack, the surface portion of the cable has a buoyant jacket to support its length.

The surface end of the cable is connected to the buoy via a water-tight swivel and slip ring. The integrity of the wire rope core is brought out at the anchor fitting so that over the 40 m between the buoy and the anchor, the cable has a breaking strength of 10,000 lbs.

The winch consists of a base frame 125 cm x 200 cm, carrying a 63 cm pitch diameter by 117 cm long grooved drum, which accommodates a single layer of 200 m of electromechanical tether cable. The cable is fed off the drum through a travelling level wind fairlead to the sensor vehicle. A 6 conductor slip ring carries sensor power and signals through the winch drum. The drum is driven by a DC motor through a gear box and chain drive. Associated with the motor is the mechanism for setting upper and lower limits of the profile and for generation of motor speed feedback. The winch drum slip ring and the motor are each contained in air pressure-compensated canisters to ensure water tightness. The motor canister also contains the power supply for the sensor vehicle.

The sensor vehicle in concept is a general purpose platform upon which sensors may be mounted. The basic electronics provides for signal conditioning to standard levels, a clock, a digitizer and special power conditioning circuits. This equipment can accommodate 16 channels of data in general application.

The sensor vehicle consists of a heavy wall cylinder 130 cm long by 20 cm inside diameter with removable sealed-end bulkheads. A 69 cm diameter syntactic foam sphere surrounds the upper part of this cylinder and the winch tether cable is mechanically terminated to a removable bridle on the bottom end.

VAPS Performance Specifications

A. Profiling Characteristics

1.	Operating Depth:	24 metres
2.	Ascent Profiling Speed:	1-1/2 to 18 cm/sec. (adjustable)
3.	Descent Profiling Speed:	2 to 14 cm/sec. (adjustable)
4.	Vertical Excursion Range: (vehicle)	1.5 m from bottom to 2 m below surface* (adjustable throughout range)
5.	Profiling Control Modes:	Manual or Automatic
6.	Unattended Profiling Endurance (AUTO):	10 days typical between tape cassette changes. 60 days minimum between diesel plant refuellings, 1 year typical between diesel plant servicing

B. General System Characteristics

1.	System Masses:	Control Panel	225 kg	(500 lb.)
		Winch	446 kg	(980 lb.)
		Vehicle	125 kg	(275 lb.)
		Shore Cable or Mooring Cable	1800 kg	(including reels) (4000 lb.)
	System Weights (in water):	Winch	1690 N	(300 lb.)
		Vehicle	+529 N	(pos. buoyancy) (120 lb.)
		Cable	343 N	(100 m length 24 lb./100 ft.
2.	Maximum Operating Conditions:	Surface current 100 cm/sec. (surface)		
	Wave Condition:	6 m trough/crest peak, 8 second period		
	Surface Wind:	30 m/sec.		

*Limited by the vehicle's approach to surface--the upper limit of approach to surface should be set below expected wave zone, lower limit dependent on sensor location on vehicle.

3.	Operating Temperature Range:	0° to +30°C
4.	Operating Depth/Pressure (max.)	200 m/1.96 M pascals (285 psi)
5.	System Power Requirements Total Input to Control Panel	120 VAC, 10 amps, 60 Hz

C. System Data Recording

1.	Cable Telemetry	
	1.1 Baud Rate	1 K Baud for data, 2 K Baud for shift clock
	1.2 Error Rate	1 in 10^8 bits
2.	Format	Start bit, 19 bit time word and up to 16 - 12 bit digital data words stored on cassette tape on shore
3.	Storage Capacity	30 million bits unformatted
4.	Accuracy	10 bits over 0° - 40°C temp. range
5.	Resolution	12 bits
6.	Electronic System Monitoring (optional)	Digital bit display onshore plus 4 channel analogue (strip chart) display

OXYGEN PROFILES

Field testing of the newly-developed oxygen profiler took place during the Anchor Study. This test not only fulfilled the requirement of bi-hourly oxygen profiles but gave numerous sets of data which could be used to assess the variations in performance among several types of sensors.

The technique used in lowering the probe was two people: one technical staff and one seaman. The seaman's task was to slowly pay out the electronics cable while keeping a watchful eye on a digital readout from the 1 mil YSI sensor. The lowering rate chosen was one that would not cause a significant change in the displayed reading. If the reading changed by more than a few counts per second, the lowering rate would slow down. The result was that in areas of the profile where oxygen levels were constant, relatively rapid rates in excess of 10 cm/sec. could be used and in rapidly changing areas such as in the thermocline region, the descent rate could be reduced to 1 cm/sec. When the probe reached bottom, the system was retrieved at the same rate as it was lowered to allow for an intercomparison between the down and up traces.

The system consisted of five major elements: a sonde, cable, analysers, analogue recorders and digital data logger. The sonde included the three D.O. sensors, a temperature sensor and a depth sensor. Power was provided to these sensors and signals returned to the surface electronics via a 60 m long, 26 conductor cable assembly. The surface components included the portable dissolved oxygen profiler and a special rack containing the Orbisphere and second YSI analyser as well as the various buffer amplifiers and digital data logger.

The analogue X-Y recorders allowed the display of temperature or any of the D.O. signals against depth. The intercomparison recorder used translucent charts so that the recordings could be overlayed for comparison.

The digital data logger recorded all five signals as well as time and header every second during each profile.

DISSOLVED OXYGEN PROBES: SUMMARY OF CHARACTERISTICS

No.	Parameter	Units	Orbisphere 2714	YSI 54A
1	Range (min. - max.)	Mg/L	0.02 to 199.9	0-10, 20
2	Accuracy	% F.S.	± 1% reading	± 1
	-over time period	Hr.		
	-temperature	°C	± 5° of cal.	
	-conc. limits	Mg/L		
3	Resolution	Mg/L	.001 (on lowest range)	0.05, 0.1
4	Probe type		Membrane	Membrane
5	Electrodes	-		Au, Ag
6	Drift	Mg/L/Du	.1% F.S./Mo.	
7	Response	S	90	10
	-63% or 90%, etc.	%	99 (90% in 15 sec.)	90
	-temperature	°C	25	30
	-Temp. Response	S		
8	Maximum depth	M	200	70
9	Outputs		*incl. probe	
	-current	MA	-	
	-voltage	MV	0-2000	0-136

No.	Parameter	Units	Orbisphere 2714	YSI 54A
10	Temp. compensation			
	-range	°C	0-100	-5 to 45
	-accuracy	% RDG	(included in 2)	$\pm$ 3
11	Required flow	CM.S	30	
12	Oxygen consumption	ug/ (hr. ppm)	.04	
13	Resistance to Poison			
	-min. conduct.	MS		
	$-NH_3$	ppm	250	
	-SO	ppm	700	
	$-H_2S$	ppm	15	
	Source of Info.		Man. Data Sheets	Instruct. Manual

NUTRIENT DYNAMICS SUPPORT

As well as the collection of water samples for M.N. Charlton, numerous cores were collected using the benthos corer. Cores were collected throughout the entire anchor station period in support of this project.

Eighteen cores were obtained for the purpose of determining O_2 profiles of the bottom 1 metre of water, comparing techniques and for chemical analyses. Several attempts at measuring the O_2 gradients near the sediment surface in core tubes showed that the new spring-loaded "benthos" valves enable core tubes to transport epilimnion water to the sediment interface. When the valves are closed by release from the surface or the older butterfly valves are used, a longer core is obtained even without weights on the corer body. Single "benthos" cores thus obtained tended to have sharper interfaces and correct O_2 and temperature due to the increased water flow. Samples were frozen for comparative chemical analysis. When the "old" butterfly valves were used on the triple corer, the apparatus sank completely into the sediment. In contrast, core tubes were only partially filled when the spring-loaded valves were used.

ORGANIC CARBON SETTLING EXPERIMENTS

F. Rosa of the Nutrient Dynamics Section, AED made day trips to the CSS LIMNOS on three occasions to run experiments designed to measure the rate of organic carbon settling through the water column. Two specific depths were chosen: at 2 m above and 1 m below the thermocline. A total of four experiments were conducted: three in the hypolimnion and one in the epilimnion waters. (Samples from the above depths were settled in the incubator at the same temperature and light intensity as the in situ conditions.) Also, suspended inorganic material (SIM) samples were collected to calculate ratios of SM:POC in the water column and in the settling chambers.

VISITING SCIENTISTS

Three groups of visiting scientists took part in the Anchor Station Experiment. The group from the U.S. Navy Undersea Systems Center has been mentioned in connection with the spar buoy discussed earlier as well as an acoustic listening device.

Professor Snodgrass from McMaster University undertook several experiments relating to the sediment oxygen demand. His sediment oxygen demand chambers were in action for most of the experiment. In addition, he sought to measure the effect of bottom currents on the oxygen demand of sediments using a box core sample and a system of closed circuit pumping. At his request, the profiling syringe sampler was deployed a number of times. Divers assisted with his program on two separate days by firing the syringe sampler, closing the box corer and moving his sediment oxygen demand chambers about the bottom.

Professor D. Adams from Wright University, Dayton, Ohio assisted by two students, collected a number of core samples for immediate and future analysis. His team visited the CSS LIMNOS on two occasions and was assisted by both divers and the CSS LIMNOS technical staff. All outside researchers agreed to make their results available to NWRI in return for the support received.

CSS ADVENT LAKE ERIE SUPPORT

The CSS ADVENT was assigned to support the experiment in a number of ways.

PLAN

Because a component of flow is known to be a persistent upwelling and mixing of hypolimnion water, temperature/depth profiles and water samples were required in the vicinity of the CATTS and current meter moorings. Water samples from surface and bottom were analysed for dissolved oxygen; at one station, additional water from a series of depths was drawn for particulate organic carbon and chlorophyll a analyses.

Hourly meteorological observations were required.

During upwell events, it was required to sample with the EBT to learn how and where the two-layer open-lake stratification gave over to a vertically mixed water column.

There was a requirement to establish whether there were significant chemical or biological gradients in the vicinity of the main Anchor Station.

Synoptic data sets were desirable and samples were to be collected for dissolved oxygen analysis and subsampled aboard the LIMNOS for various chemical analyses.

Personnel and equipment transfers between the ADVENT and LIMNOS were scheduled on a daily basis. Personnel were brought from Erieau to the LIMNOS during the morning and returned to Erieau in the evening.

FIELD OPERATIONS

Water sampling in the vicinity of CATTS and current meter moorings came under the heading of Northshore "Thermocline Contact" Cruises. Seven (7) such cruises were carried out as follows:

THERMOCLINE CONTACT CRUISE SUMMARY

TCC No.	No. of Stations	Date
1	11	July 29
2	18	August 6
3	10	August 8
4	33	August 12
5	25	August 21
6	25	August 27
7	30	August 28

Sampling during upwelling events to determine where the thermocline ended and where mixed water began (as close to shore as feasible) was carried out as often as possible during Thermocline Contact Cruises.

Meteorological parameters were observed at all stations.

Water sampling in the vicinity of the main Anchor Station came under the heading of Mid-Lake Small Scale Surveys. Five (5) such cruises were carried out as follows:

MID-LAKE SMALL SCALE SURVEY SUMMARY

ML Survey No.	No. of Stations	Date
1	16	August 13
2	2 (Rough Weather)	August 14
3	18	August 15
4	16	August 19
5	9	August 20

Large volume (4ℓ) samples for splitting aboard the LIMNOS were stored in ice in a rented, insulated stainless steel, used, bulk milk carrier.

MOORINGS

CSS ADVENT installed, serviced and retrieved the CATTS moorings with assistance from the Dive Unit. CSS ADVENT monitored, serviced and stripped FTP and Met. buoys and assisted in the VAPS experiment.

CHEMISTRY

Dissolved oxygen samples were analysed in a rented laboratory on shore. Filtrations for POC and chlorophyll a were performed aboard the CSS ADVENT.

PERSONNEL AND EQUIPMENT TRANSFER

This phase of the field operation went well, showing foresight for the intensive period. On one trip there was a total of seventeen (17) people aboard the ADVENT for most of the day; most days there were 12 to 15 persons aboard. On August 18 there were four vessels--CSS LIMNOS, HYDRA, ADVENT and SHARK plus VAPS buoy and barge involved with this project; at the same time there were eight (8) project-associated vehicles on the wharf at Erieau and forty-four (44) persons working on the project, not including HYDRA personnel.

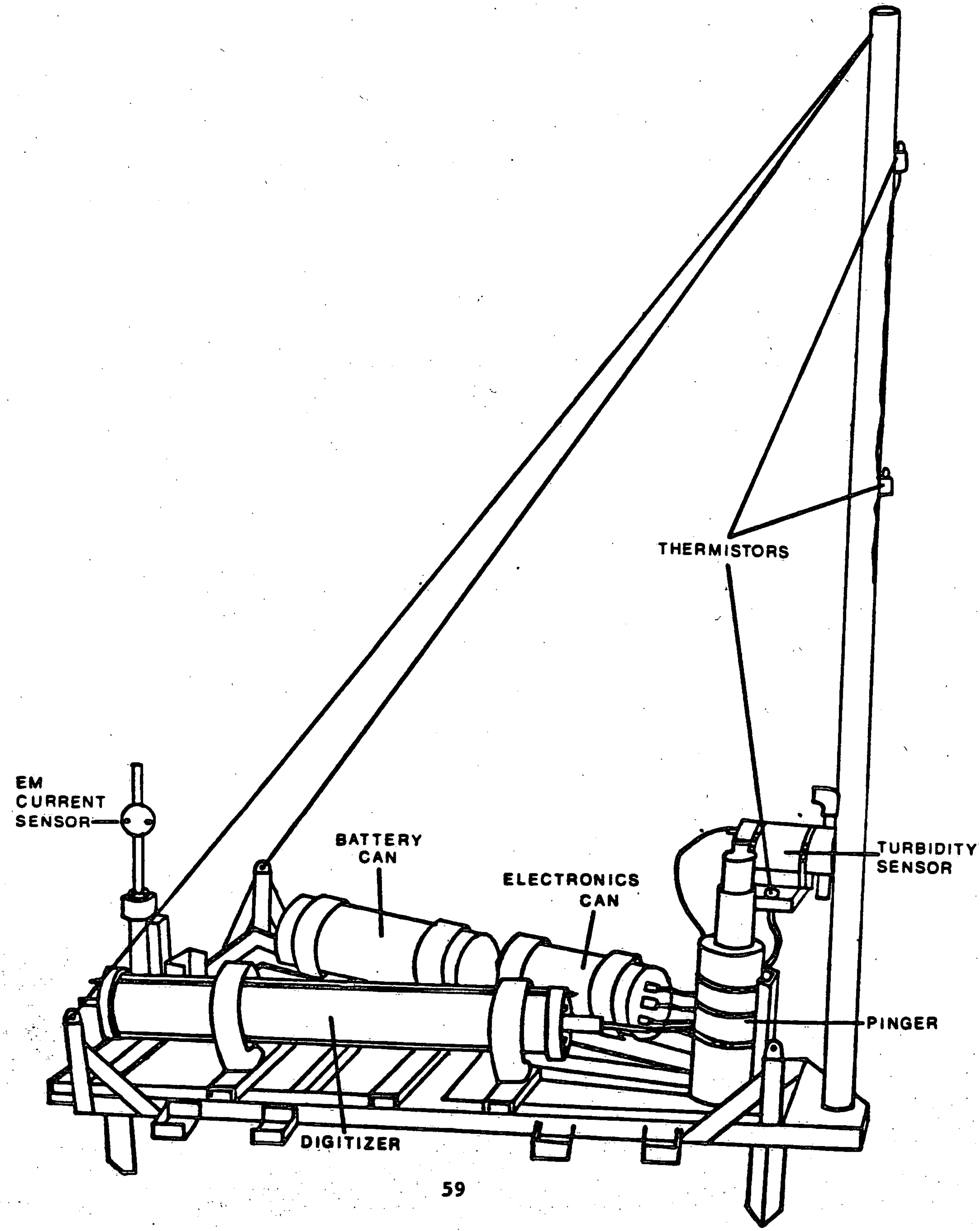
CATTS

The two CATTS instrument packages were installed in 10 metres of water on the North shore of Lake Erie at positions 42° 13' 24" N., 82° 06' 30" W. (CATTS East) and 42° 11' 00" N., 82° 11' 18" W. (CATTS West).

The CSS ADVENT was utilized for these installations and though she is not fitted out suitably for diving, the ship's company were able to ensure reasonable safety for the installation.

The CATTS instruments were recovered using the CSS ADVENT and were returned to CCIW September 6, 1980.

C.A.T.T.S.


THERMISTORS
EM
CURRENT
SENSOR
BATTERY
CAN
ELECTRONICS
CAN
TURBIDITY
SENSOR
PINGER
DIGITIZER

RECOMMENDATIONS

1. CSS ADVENT

a) A diver access ladder should be installed or be made available when divers are working from the ship.

b) The hydraulic crane system should be made independent of the ship's engines so that the crane can be utilized without the main engines running.

2. ROSETTE/EBT

There should be a complete set of interchangeable parts for the rosette and EBT systems carried aboard the ship at all times. Included in these parts should be interchangeable bodies and cages in case of cable breakage.

3. If a project of this nature is to be conducted in the future, a total of 16 scientific and technical staff, as the Anchor Station, although successful, proved to be overcrowded on several occasions to the extent that operationally the project began to suffer.

4. METEOROLOGICAL BUOYS

Either the arms of the buoys have rubber sleeves attached or eye bolts should be installed in order for the small boat which monitors the buoy can be secured without chaffing its mooring lines off.

5. BENTHOS CORES

Any cores collected in the future should be collected using the old butterfly valves. The new spring valves were found to compress the core and drag epilimnion waters down to the sediment water interface.

6. FTP MOORINGS

A proper flashing light (Xenon) should be used on the FTP mooring. This should be done as light on the buoy is very close to the water surface and is barely visible in any type of inclement weather.

7. SYRINGE SAMPLER

Before the syringe sampler is used again, it should have a complete rebuild. The syringes either stick or they aerate the sample making it totally useless for oxygen measurements.

CONCLUSION

The Lake Erie Project, although demanding at times, proved to be very successful from a Technical Operations perspective. All aspects of the work were completed without personnel injuries, loss of time or loss of equipment.