I.O.S.

OFFSHORE TIDE GAUGE & MOORED CURRENT METER RECORDS FROM THE IRISH SEA, 1977

by

G. A. ALCOCK AND M. J. HOWARTH

DATA REPORT No. 15

1978

NATURAL ENVIRONMENT RESEARCH COUNCIL

INSTITUTE OF OCEANOGRAPHIC SCIENCES

INSTITUTE OF OCEANOGRAPHIC SCIENCES

Wormley, Godalming,
Surrey, GU8 5UB.
(0428 - 79 - 4141)

(Director: Dr. A.S. Laughton)

Bidston Observatory,
Birkenhead,
Merseyside, L43 7RA.
(051 - 653 - 8633)

(Assistant Director: Dr. D.E. Cartwright)

Crossway,
Taunton,
Somerset, TA1 2DW.
(0823 - 86211)

(Assistant Director: M.J. Tucker)

OFFSHORE TIDE GAUGE & MOORED CURRENT METER RECORDS FROM THE IRISH SEA, 1977

G.A. ALCOCK AND M.J. HOWARTH

DATA REPORT No. 15

1978

Institute of Oceanographic Sciences
Bidston Observatory
Birkenhead
Merseyside L43 7RA

TABLE OF CONTENTS

Abstract

This report describes the pressure and current data gathered by IOS Bidston in three separate exercises in 1977 in the Eastern Irish Sea. A brief description of the instruments, mooring configurations and data processing is followed by sections on the pressure data and on the current data. Details of the deployment and recovery of each meter are given. For the pressure records the measurements are presented both in graphical form and in tables of harmonic constants. For the current records the data are displayed in a set of plots.

1. INTRODUCTION

(i) MARCH/APRIL 1977

An experiment was conducted in the Eastern Irish Sea to study tidal and residual currents for a month when the water column was vertically homogeneous. 24 current meter rigs were deployed and the density structure measured by continuous surface monitoring of conductivity and temperature, WILSON et al (1975), and by taking profiles. Additional experiments were the calculation of bottom friction from the measurement of surface slope and current profile, BOWDEN et al (1952), and the measurement of tidal elevations at two sites near the Lake District for an earth tide study, EDGE et al (1978).

The experiment was jointly conducted with the Fisheries Laboratory, Lowestoft who deployed 16 current meters in 11 rigs. This report presents the data gathered by IOS Bidston from 19 current meters in 11 rigs, 2 bottom mounted current/tide gauges and 3 off-shore tide gauges, see Fig. 1 and Tables 1 and 2. A description of the cruise is given in IOS Cruise Report No. 66 (1977).

All the Bidston current meters were manufactured by Aanderaa, AANDERAA (1964). Their data return was 86% of planned data (including one meter not recovered). Loss of data was caused by 2 internal meter failures (2%), 3 rigging malfunctions (6%) and trawling activity (6%). The rigging malfunctions occurred when a meter was deployed tangled with the ground line (see Figure 5), when a meter was molested by its surface buoy line after the line had parted company with its anchor and when a bottom mounted tide gauge/current meter rolled over and then righted itself on three occasions. The trawling activity removed 3 surface buoys and 1 complete rig, all of which were subsequently recovered drifting

except for one current meter.

Table 3 shows the types of tide gauge deployed. All worked well except for one pressure sensor (out of five) which flooded at station 35, and one pressure sensor (out of three) which produced a very noisy and intermittent record due to failure of electronics.

(ii) MAY/AUGUST 1977

The tide gauge was deployed for the Mersey Docks and Harbour Company as part of an investigation into offshore and onshore tidal levels in Liverpool Bay (see Table 3 and ALCOCK (1979)). 100% of data was recovered.

(iii) OCTOBER/NOVEMBER 1977

A joint experiment was conducted with IOS Wormley and the Marine Science Laboratories, Menai Bridge to compare the currents recorded by AMF Vector Averaging Current Meters (VACM) and Aanderaa current meters on sub-surface moorings and those measured by telemetering drogue buoys, LAST (1976). This experiment was preceeded by a smaller experiment in 1975, BOOTH (1978).

Four rigs and three drogue buoys were deployed, see Figure 2 and Table 1. Three rigs (A, B, C) comprised one VACM and one Aanderaa each and rig D three Aanderaas (plus two fast sample Aanderaas for engineering trials) and two bottom mounted pressure sensors. An Aanderaa meter was attached to one of the drogue buoys but the wire parted and the meter was not recovered.

The Aanderaa data is presented in this report for which the data return was 67% of planned data. Loss of data was caused by,
a) trawling activity (17%) - rig A was missing when recovery was

attempted and although the VACM was later washed ashore the Aanderaa has not been recovered and, b) rigging malfunction (17%) - a meter was deployed tangled with the groundline. The VACM's returned one good record, A, one 26 day record before its compass came loose, B, and no data from C, which appeared to have a fault in the speed measurement.

There were two pressure recorders in the frame at D, see table 3. The Aanderaa gaugè worked well throughout and the development meter returned 31 days data before its batteries failed.

2. INSTRUMENTATION

(i) TYPE II O.S.T.G.

This type of Off Shore Tide Gauge has previously been deployed by I.O.S. (Bidston) at 12 sites in the shelf seas around the United Kingdom (ALCOCK and VASSIE 1975 and 1977). The data logger can sample a maximum of twenty input channels at periodic intervals and record their values by means of an incremental tape recorder in a computer compatible format. An integration time of 899.994s and sampling time of 900s for each channel were used for the deployments at stations 35 and 33, and all twenty channels were used in order, where possible, to achieve redundancy by recording on two separate channels the output from each pressure or temperature transducer. Channel 1 is used for recording elapsed time and is permanently held open to count elapsed time pulses derived from a crystal oscillator. All integration, gating and recording periods are controlled by a second crystal oscillator. The recording format of the sampled data is 7 track NRZI, 200 characters per inch and 1280 characters per block. The data being recorded on the tape may be monitored on board ship while the tide gauge is on the sea bed using a direct wire telemetry link to a teleprinter.

Sensor packs used with the logger incorporated both a pressure and a temperature sensor and were completely self-contained units with their own sensor electronics and power supplies. Different types of pressure sensors based on either vibrating wire, quartz crystal or strain gauge transducer systems were used on the tide gauge. The vibrating wire sensors, VIB 1/5 and VIB 1/6 each contain a Vibrotron model 8140 pressure transducer in which a tungsten wire is stretched between a rigid frame and a diaphragm

and mounted in a magnetic field. Any movement of the diaphragm due to a change in pressure will increase or decrease the tension of the wire and hence change its natural period of oscillation. The wire is connected in the feed-back loop of an amplifier and this makes a variable frequency oscillator where frequency is a function of pressure. To achieve temperature compensation, the coefficient of expansion of the supporting frame is designed to balance the expansion of the wire and the transducer of the sensor is evacuated. The temperature sensor uses a platinum resistance thermometer mounted into the same copper heat sink as the pressure sensor and forms one arm of a Wheatstone bridge network (BUTLIN 1974). Improved electronic circuits with voltage stabilisers were used. (ALCOCK and VASSIE 1977).

The quartz crystal sensor, DS6/1, used a Digiquartz model 4270 depth sensor pack which consists of a 39 kHz quartz resonator coupled by piezoelectric action to an electronic oscillator. The transducer used had a crystal with a turning point at about 6 to 8 ^{o}C, so that the temperature coefficient was a minimum at this temperature.

Each of the strain gauge sensors used, except SG2/9, was developed using a Bell and Howell type 4-306 pressure transducer and operates as a phase shift oscillator whose frequency is controlled by the ratio of output to input voltage of the transducer Wheatstone bridge network. SG2/9 contains a Bell and Howell type 4-800 thin film transducer whose mode of operation is described in section iv). Strain gauge sensor SG 2/4 and SG 2/6 were each housed in the type of case used in previous deployments, but SG2/7, and SG2/8, and 2/9 were each housed in an Aanderaa current meter case, with the pressure

transducer and platinum resistance thermometer both screwed into a 0.5 inch thick stainless steel end cap. All five strain gauge sensor packs incorporated the improved electronic circuits fitted with voltage regulators and first used with strain gauge sensors deployed during the JONSDAP 76 exercise (ALCOCK and VASSIE 1977).

All the calibrations of the pressure and temperature sensor packs were carried out by members of the Reseach Technology Group using equipment and facilities at Bidston. For station 33, the sensors VIB1/6, SG2/6, and SG2/9 had pressure sensitivities of 0.037 Hz mb^{-1}, 0.067 Hz mb^{-1}, and 0.074 Hz mb^{-1} respectively; and temperature coefficients of 10.9 mb $^{o}C^{-1}$, 59.0 mb $^{o}C^{-1}$, and 6.0 mb $^{o}C^{-1}$ respectively. For station 35, the sensors VIB1/5, DS6/1, SG2/4 & SG2/7 had pressure sensitivities of 0.036 Hz mb^{-1}, 0.164 Hz mb^{-1}, 0.056 Hz mb^{-1} and 0.129 Hz mb^{-1} respectively; and temperature coefficients of 0.9 mb $^{o}C^{-1}$, 0.0 mb $^{o}C^{-1}$, 5.2 mb $^{o}C^{-1}$, and 11.2 mb $^{o}C^{-1}$ respectively. SG2/8 was not calibrated as no data was recorded from either the pressure or temperature sensor.

The data logger and its batteries were housed in a 0.56m diameter aluminium sphere with sufficient space left within the sphere for sensor batteries, acoustic release electronics and ancillary sensor electronics. Water tight connectors mounted on the ports of the sphere enable sensors external to the sphere to be powered and their output signals fed into the sphere. The sphere and the sensor packs were mounted in an aluminium sub-frame which in turn was protected by a heavy steel outer frame.

ii) AANDERAA O.S.T.G. TYPE 2A

The gauge deployed at stations 34 and Queens Channel was an

Aanderaa type 2A, serial number 64, which uses a Digiquartz type 2-300A quartz crystal pressure transducer. The pressure frequency count from the transducer was integrated over approximately 104s, sampled every 900s, and recorded on 0.25 inch magnetic tape on an Aanderaa logger housed in the same case. A quartz crystal clock was used for controlling the sampling interval and the data were recorded as 10 bit binary words in serial form, with the frequency count from the sensor stored as most and least significant counts. No temperature sensor was contained in the sensor pack. Pressure sensitivities were 0.186 HZ mb^{-1} and 0.258 HZ mb^{-1} for stations 34 and Queens Channel respectively.

The sensor pack was mounted in a low profile steel tripod frame of 0.76m height and 1.183m breadth with the sensor level about 0.48m above the frame base.

iii) BOTTOM MOUNTED CURRENT METER/TIDE GAUGE

The bottom mounted gauges deployed at station 10 and 12 utilised a Digiquartz pressure sensor and an Aanderaa current meter (with the adaption of a small direction vane replacing the normal large vane) both interfaced into a modified Aanderaa current meter logger. Current speed and pressure frequency count were integrated over 600s and sampled every 600s, together with spot readings of vane direction, temperature, elapsed time, and rig orientation. A quartz crystal clock was used for controlling the sampling interval and the data were recorded on 0.25 inch magnetic tape as 10 bit binary words in serial form with the frequency count for the pressure sensor stored as most and least significant counts. Each pressure sensor pack contained a Digiquartz type 2-300A quartz crystal pressure transducer but no temperature transducer. At station 10,

CM/TG no. 1 was used with sensor pack DIG 5/2 containing transducer SN 280 with a pressure sensitivity of 0.150 HZ mb^{-1}. At station 12, CM/TG no. 2 was used with sensor pack DIG 5/1 containing transducer SN 275 with a pressure sensitivity of 0.157 HZ mb^{-1}.

The pressure sensor pack and current meter pack were mounted approximately 1m and 0.7m above the rig base respectively, and dimensions of the rig were overall height 1.5m and its base was formed by a tripod with legs of length 0.7m.

iv) COMBINED CURRENT METER STRING AND BOTTOM INSTRUMENT FRAME

At station D, a conventional single wire current meter string was used with the anchor chain replaced by a small aluminium instrument frame 0.6m in diameter by 0.6m high and mounted on a 0.65m square base. The frame was connected to a wide based 2m square steel ballast frame by an acoustic release unit. The instrument frame can take up to four 0.12m diameter instruments mounted approximately 0.5m above the frame base and for the deployment at station D, the Aanderaa type 2A/64 tide gauge described above, an Aanderaa TG/SG 280 tide gauge, and an acoustic release unit were used. The Aanderaa TG/SG 280 tide gauge consists of an Aanderaa current meter type logger modified to accept inputs from sensor pack SG2/9, containing a Bell and Howell type 4-800 thin film strain gauge pressure transducer and a platinum resistance thermometer. The pressure transducer has an insulated thin metal film on its diaphragm which is etched to produce a precise strain gauge pattern whose output forms one arm of the conventional strain gauge Wheatstone bridge network. The sensors were housed in an aluminium sleeve mounted inside a nylon block inside the pressure case and designed to give

a long thermal time constant of the pressure transducer and hence minimise dynamic thermal effects. Pressure sensitivity of the thin film strain gauge was 0.073 HZ mb^{-1} with a temperature coefficient of 4.5 mb $^{o}C^{-1}$. Pressure sensitivity of the Aanderaa type 2A/64 pressure sensor was 0.260 HZ mb^{-1}.

(v) CURRENT METER

An Aanderaa RCM4 current meter is a self-contained instrument for measuring water temperature, integrated rotor count and direction. It consists of a recording unit, spindle and vane. The recording unit houses a rotor, thermistor, compass, quartz-crystal clock, tape deck for ¼" magnetic tape and encoder - a self-balancing bridge which converts the output from the sensors into a ten bit binary number. The spindle is spliced into the mooring wire and has a gimbal mounting which allows $\pm 27^{o}$ tilt between the spindle and the meter. The vane aligns the meter with the flow and is a 1.00m x 0.37m PVC sheet to which is fitted a pair of small horizontal stabiliser fins and a weight to balance the meter.

In the past, the spindles had often been recovered damaged or corroded and so a better quality spindle has been designed at Bidston, CHIVERS (1975). This was fitted to twelve of the meters. A pressure sensor, consisting of a bourdon tube which drives a potentiometer, was fitted to 18 meters: 12 had a range 0-14 bar and 6 a range 0-7 bar. The sampling interval for each of the meters was either 10 or 15 minutes and was controlled by a clock rated at ± 2 seconds/day. Two meters had errors exceeding -3.6 seconds/day slow and 2.2 seconds/day fast. Timing errors were determined by comparing the number of samples recorded with the difference between the times of starting and stopping the meters.

The meters were started on board ship during the launch leg and were stopped during the recovery cruise but had pre- and post-cruise checks performed on them in the laboratory.

All meters were calibrated before their launch and after their recovery. The thermistors were calibrated over the range -2°C to 20°C in a water bath. A cubic polynomial was fitted to the results of each calibration. The compasses were calibrated every 10° from 0 to 360° and every degree through its dead-space. This calibration was performed on Bidston Hill with the meters in a special jig. The results were used to create a table which contained the direction (to the nearest degree) corresponding to each meter reading. The pressure sensors were calibrated over the range 0 to 13.5 bars or 0 to 6 bars above atmospheric pressure using a dead weight tester and a straight line fitted to the results. The rotors were not calibrated but the manufacturer's formula was used since experience had shown this to be sufficiently accurate. The meters were also balanced in a salt water solution to ensure that the fins were horizontal in the sea.

3. MOORING CONFIGURATIONS

Schematic diagrams of the various mooring arrangements are shown in Figures 3, 4 and 5. The idea is the same in all cases and is a standard shallow water rig designed to give surface warning of the rig, to provide a back-up recovery method by dragging for the ground-line and, for the current meter rig, to reduce the effect of surface waves on the meters.

Two different types of main surface marker were used:-

(A) A toroidal buoy 1.8m in diameter with 600 kg of buoyancy. The buoy supported a framework for a radar reflector and flashing light. A 2m length of scrap chain was suspended below the buoy to give it some form of stability, but despite this the buoys overturned several times.

(B) A pillar buoy 3m in overall length with 450 kg of buoyancy. 1m of the buoy showed above the surface and contained an integral radar reflection and flashing light.

For the current meter rig, shown in fig. 5, the current meter spindles were spliced into a taut line supported by a hollow steel sphere forming a sub-surface buoy. In the majority of rigs the sphere was 0.8m in diameter, giving a net buoyancy of 175 Kg at a weight of 115 kg. For two rigs, 11 in March/April and D in Oct/Nov a 1m diameter buoy was deployed, giving a net buoyancy of 260 kg for a weight of 290 kg. The meter wire was made from a wire rope of 8mm diameter galvanised, flexible steel. An acoustic command pinger was spliced into the meter wire on each current meter rig to aid re-location if the surface buoy was missing when recovery was attempted.

In all cases the ground line and surface buoy line were of 12mm wire and were approximately 3 times and 1½ times the water depth respectively. All wire terminations were made with the aid of tellurite ferrules and connections were made with D shackles, rings and reciprous bearing swivels.

Figure 3 shows the arrangement for the bottom mounted current meter/tide gauge, Figure 4 for Mk II and Aanderaa 2A OSTG. For the latter there was no telemetry link and when deployed in the Queen's Channel the pillar buoy was replaced by a toroid and the spar buoy by pellet floats. Figure 5 shows the arrangement for the current meter rig and the rig D in Oct/Nov when the meter anchor was replaced by a ballast frame containing a pressure recorder.

For tide gauge rigs the surface buoy was deployed first and the spar buoy last whilst for current meter rigs the sub-surface buoy was deployed first and the surface buoy last. The procedures were reversed for recovery. For the Mk II gauges a telemetry link was taped to the wire and after satisfactory data had been received from the gauge on deployment in the sea bed, the link was disconnected.

For March/April, when the RRS John Murray was used and for May/Aug when the SS Salvor was used the vessels kept under way during deployment and recovery. In Oct/Nov when the RV Prince Madog was used the ship anchored before deployment and recovery and used its winches to move about. The skill and experience of the masters and crew of the ships contributed greatly to the success of the programmes.

4. DATA PROCESSING - PRESSURE RECORDS

The magnetic tape from each of the Mk II O.S.T.Gs deployed at stations 33 and 35 was copied, with a density of 800 bpi, onto a 9 track magnetic tape using the IBM 370/145 computer at the IBM centre at Manchester; the 9 track tape was taken to the SRC Daresbury Laboratory and the data read into disk storage on the IBM 370/165 computer. As an initial check on the raw data, each temperature and pressure frequency channel was plotted. A program was then used to check the frequency data from each temperature sensor channel, calculate and plot the temperatures and store them on disk. A second program checked and calculated the frequencies from each pressure sensor channel, used the temperature value and the pressure frequency/temperature coefficient to convert each pressure frequency to the frequency at the reference temperature, and calculated the pressures using the pressure/frequency calibration. The ¼h values of pressure were plotted, stored on disk and punched on cards.

The magnetic tape from the logger of the Aanderaa O.S.T.G. type 2A was translated into a paper tape containing the pressure data and these were read into disk storage on the IBM 1130 computer at Bidston and then transferred into disk storage on the IBM 370/165 at Daresbury using the 1130 as a RJE (Remote Job Entry) terminal, and the same programs used to compute the ¼h values of total pressure except that no temperature corrections were made.

The magnetic tape from the logger of each of the bottom mounted current meter/tide gauges deployed at stations 10 and 12 was translated into two paper tapes which contained i) elapsed time, current meter and temperature data, ii) elapsed time and pressure data.

The magnetic tape from the logger of the Aanderaa TG/SG280 tide gauge was translated into two paper tapes which contained i) elapsed time and pressure data, ii) elapsed time and temperature data. The data from all four of these tapes were read into disk storage on the IBM 1130, the pressure and temperature data transferred to disk storage on the IBM 370/165 at Daresbury, and the same programs as for the Mk II gauge used to compute the ¼h values of total pressure.

An interpolation program was used to produce an output of hourly values, on the hour (GMT), of the pressure record. This program smoothed the data using a low pass filter, FLPO3, of half length 18 and a cut-off frequency (half-power point) of 0.35 cph (126^{o} per hour) - thus the amplitude response of the sixth diurnal band was -0.08 dB (1%). The resulting series was then interpolated, using a cubic spline, to obtain the hourly values, applying time corrections if the clock was fast or slow. (Exact times of scans at the beginning and end of the record were noted prior to launch and after recovery). Root mean square errors due to the interpolation method are of the order of 0.02mb.

5. ANALYSIS OF TIDAL DATA

The series of hourly values of the sea bed pressure contained components of sensor drift and external surges as well as the desired tidal signal. The data were filtered with a high power high pass filter, FHP53, (ALCOCK and VASSIE 1975) which removed jointly sensor drift, long period tides and surge activity, and isolated the tidal signal. For the deployment in Queens Channel, hourly computed elevation of the sea surface was required for a comparison of off-shore and on-shore elevations (ALCOCK 1979), and so hourly values of atmospheric pressure at Bidston Observatory (corrected to Mean Sea Level) were subtracted from the total pressure record to give hourly values of water pressure. The water pressures were converted to elevation using the hydrostatic equation, for which the appropriate value of density was calculated from measurements supplied by the Mersey Docks and Harbour Company.

Tidal analyses of a 29 day period, or as close to 29 days as possible, of the hourly record were carried out using the T.I.R.A. (Tidal Institute Recursive Analysis) program which utilises the harmonic method of analysis. The amplitude and phase lag relative to Greenwich epoch of 27 major and 8 related constituents were computed, the time zone being Greenwich Mean Time (S=0). The constituents π1, P1, ψ1, Ø1, 2N2, ν2, T2 and K2 are not separable from the major harmonic constants with only one month of data, and so were related to the major constituents using values derived from the harmonic analysis of at least one year's data from a nearby shore tide gauge. When there were analyses from more than one pressure sensor, a vector mean of each harmonic constant was computed.

For stations 10 and 12, a common 15 day period of filtered data was analysed with 22 major and 17 related constituents computed. Related constituents were σ1, Q1, ρ1, π1, P1, S1, ψ1, ϕ1, J1, MNS2, μ2, N2, ν2, L2, T2, K2, and MSN2. A common 15 day period of filtered data from the two sensors at station D was also analysed as well as a 29 day period of filtered data from the Aanderaa O.S.T.G. type 2A.

Apart from the deployment at Queens Channel, the amplitude of each harmonic constant in the following tables is in units of pressure (millibars). It can be readily converted to sea surface elevation using the hydrostatic relation

$$H = P/\rho g,$$

where h is elevation in metres, P is pressure in pascals (1 Pa = 10^{-2} mb), ρ is sea water density in kilograms per cubic metre and g is acceleration due to gravity in metres per second squared. Values of ρ, derived from CTD casts, and g for each station are given in the launch and recovery details.

6. DATA PROCESSING - CURRENT METERS

The data on the magnetic tapes from the Bergen meters was translated at Bidston on to punched paper tape which was input into the Institute's IBM 1130 computer. Errors in the data were discovered by noting either discontinuities in the records or consecutive readings with the same value; the most common errors being:-

(a) A large change in direction between adjacent readings at times of reasonable speed - $> 0.25 m\ s^{-1}$. This is probably caused by the meter's encoder misreading the compass.

(b) The rotor count going backwards. This often occurs when the rotor potentiometer is in its dead-space.

Errors of type (b) were corrected and the meter calibrations were then used to calculate the temperature, pressure and the North (true) and East components of velocity. Because the meter integrates the rotor count but records instantaneous directions, some further averaging was necessary to derive a similtaneous reading of speed and direction. Consider three adjacent readings of rotor count and direction at times t1, t2, t3. The value for speed and direction at t2 was derived by associating the speed given by the rotor count at t3 minus that at t1 with the instantaneous measurement of direction at time t2.

After the components of velocity had been calculated errors of type (a), which were more common than those of type (b), were corrected using a cubic spline routine on each velocity component.

REFERENCES

AANDERAA, I. 1964 A recording and telemetering instrument. Nato subcommittee on oceanographic research. Tech. Rep. 16 - fixed buoy project. 46 pp & figs.

ALCOCK, G.A. 1979 Comparison of offshore tide levels in Liverpool Bay with simultaneous on-shore levels. In preparation.

ALCOCK, G.A. & VASSIE, J.M. 1975 Offshore tide gauge data. Institute of Oceanographic Sciences, Data Report No. 7.

ALCOCK, G.A. & VASSIE, J.M. 1977 Offshore tide gauge data. Institute of Oceanographic Sciences, Data Report No. 10.

BOOTH, D.A., HOWARTH, M.J., DURANCE, J.A. & SIMPSON J.H. 1978 A comparison of residual currents estimated with current meters and a parachute droguein a shallow sea. Deutsche Hydrographische Zeitschrift 31, 237-248.

BOWDEN, K.F. & FAIRBAIRN, L.A. 1952 A determination of the frictional forces in a tidal current. Proc. Roy. Soc, A, 214 371-392.

BUTLIN, R.S. 1974 Description of a phase shift oscillator circuit for temperature and pressure measurements. Institute of Oceanographic Sciences. Report No. 8.

CHIVERS, I.G. 1975 Design modification to the Aanderaa current meter spindle assembly. Institute of Oceanographic Sciences, Report No. 19.

EDGE, R.J., BAKER, T.F., & JEFFRIES, J.G. 1978 Tilt in the English Lake District. Proc. Workshop on monitoring crustal dynamics in earthquake zones. Strasbourg Sept. 1978.

INSTITUTE OF OCEANOGRAPHIC SCIENCES 1977 Cruise Report No. 66.

LAST, J.D., PRIOR-JONES, RL.L., ROBERTS, E.W., & SIMPSON, J.H. 1976 A new Lagrangian drogue tracking system. Riv. ital. Geophys. 3, 245-251.

WILSON, T.R.S. & HARRISON, A.J. 1975 Submerged pump systems for underway monitoring at the sea surface, using a conventional STD or CTD unit. Deep-Sea Research 22(8), 571-574.

Mooring number	Rig	Latitude N	Longitude W	Water depth below chart datum (m)	Day Launched 1977	Day Recovered 1977	Height of meter above sea floor (m)	Tape number
119	3	53°28.9'	3°29.2'	21	16 March	16 April	8	25 76/1
120	9	53°46.2'	3°17.8'	15	16 March	19 April	6	1867/3
121	6	53°41.3'	3°32.3'	38	16 March	16 April	18	236/10
							8	406/10
122	10	53°46.4'	3°42.3'	37	16 March	17 April	0.7	1747/6
123	11	53°46.1'	3°55.4'	41	16 March	-	25	2573/1
							16	568/6
							8	1001/4
124	1	53°23.6'	3°45.5'	21	19 March	17 April	5	416/6
125	12	53°46.4'	4°08.1'	42	19 March	18 April	0.7	1507/2
126	8	53°38.8'	4°21.8'	59	19 March	18 April	35	566/4
							33	2574/1
							8	1139/7
127	16	53°54.0'	4°24.6'	56	19 March	18 April	35	1750/5
							8	1506/2
128	2	53°24.0'	3°55.5'	22	20 March	19 April	11	1749/4
129	13	53°53.6'	3°30.3	21	20 March	26 April	8	2575/1
130	15	54°01.3'	3°55.3'	37	20 March	24 April	24	1508/4
							8	1865/1
131	19	53°53.9'	4°46.2'	19	24 March	25 April	51	570/8
							8	567/7

Table 1. Current meter rigs for March/April 1977

Mooring number	Rig	Latitude N	Longitude W	Water depth below chart datum (m)	Day Launched 1977	Day Recovered 1977	Height of meter above sea floor (m)	Tape number
137	D	53°45.8'	4°07.0'	42	17 Oct	25 Nov	22	567/8
							19	2574/2
							16	2575/3
							11	1865/2
							8	1139/8
138	A	53°43.1'	4°13.6'	42	18 Oct	-	21	416/7
139	B	53°35.3'	4°05.5'	44	18 Oct	29 Nov	22	1508/5
140	C	53°43.0'	3°59.1'	39	18 Oct	25 Nov	19	1749/5

Table 2. Current meter rigs for Oct/Nov 1977

Rig	Latitude N	Longitude W	Day Launched 1977	Day Recovered 1977	Water depth below chart datum (m)	Type
10	53°46.4'	3°42.3'	16 March	16 April	37	Bottom mounted cm/tg
12	53°46.4'	4°08.1'	19 March	18 April	42	Bottom mounted cm/tg
33	52°04.1'	5°47.0'	22 March	27 April	94	OSTG MkII 3 sensors
34	54°09.2'	3°40.3'	21 March	24 April	31	Aanderaa 2A
35	54°39.0'	3°54.6'	21 March	24 April	28	OSTG Mk II 5 sensors
Queen's Channel	53°30.8'	3°11.9'	20 May	8 August	19	Aanderaa 2A
D	53°45.8'	4°07.0'	17 Oct	25 Nov	42	Aanderaa 2A/ Development

Table 3. Off-shore tide gauge sites for 1977

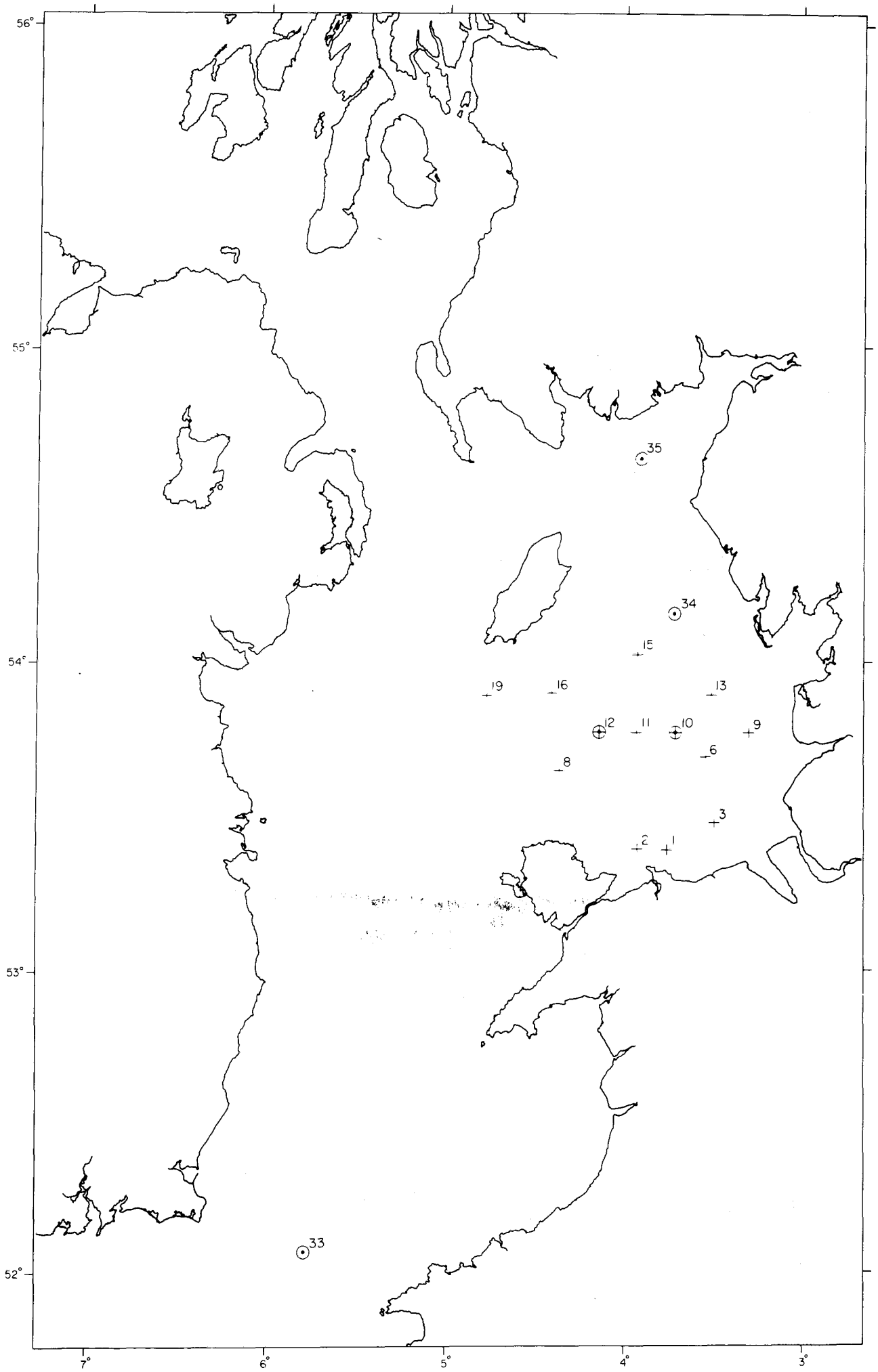


FIGURE 1. IRISH SEA DEPLOYMENT INDICATING STATION NUMBERS.
KEY: + CURRENT METER RIG, ⊙ TIDE GAUGE, ⊕ BOTTOM MOUNTED CURRENT METER / TIDE GAUGE

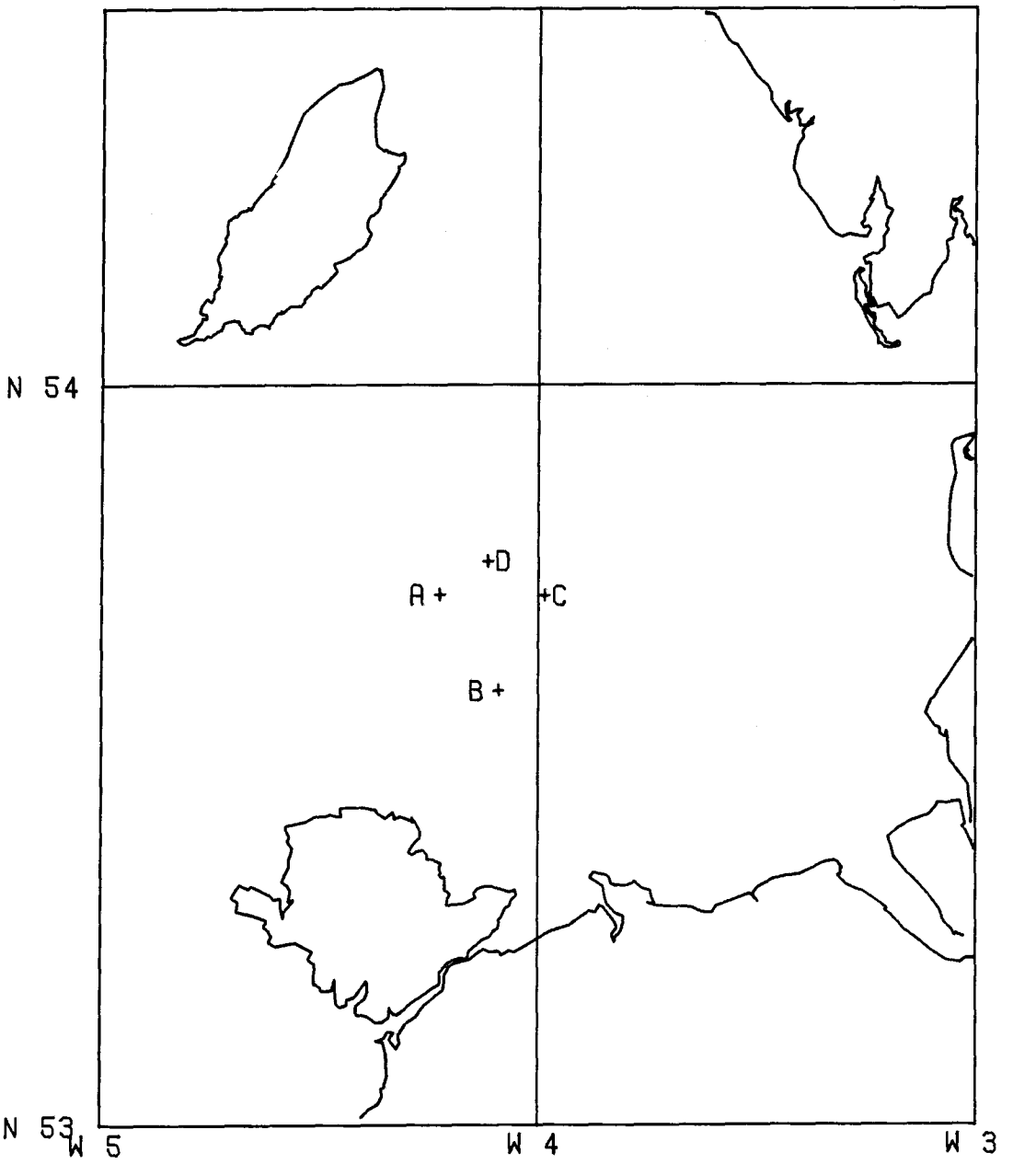


FIGURE 2. CURRENT METER STATIONS IRISH SEA OCT/NOV 1977.

BOTTOM MOUNTED CURRENT METER / TIDE GAUGE MOORING SYSTEM

INSTITUTE OF OCEANOGRAPHIC SCIENCES BIDSTON

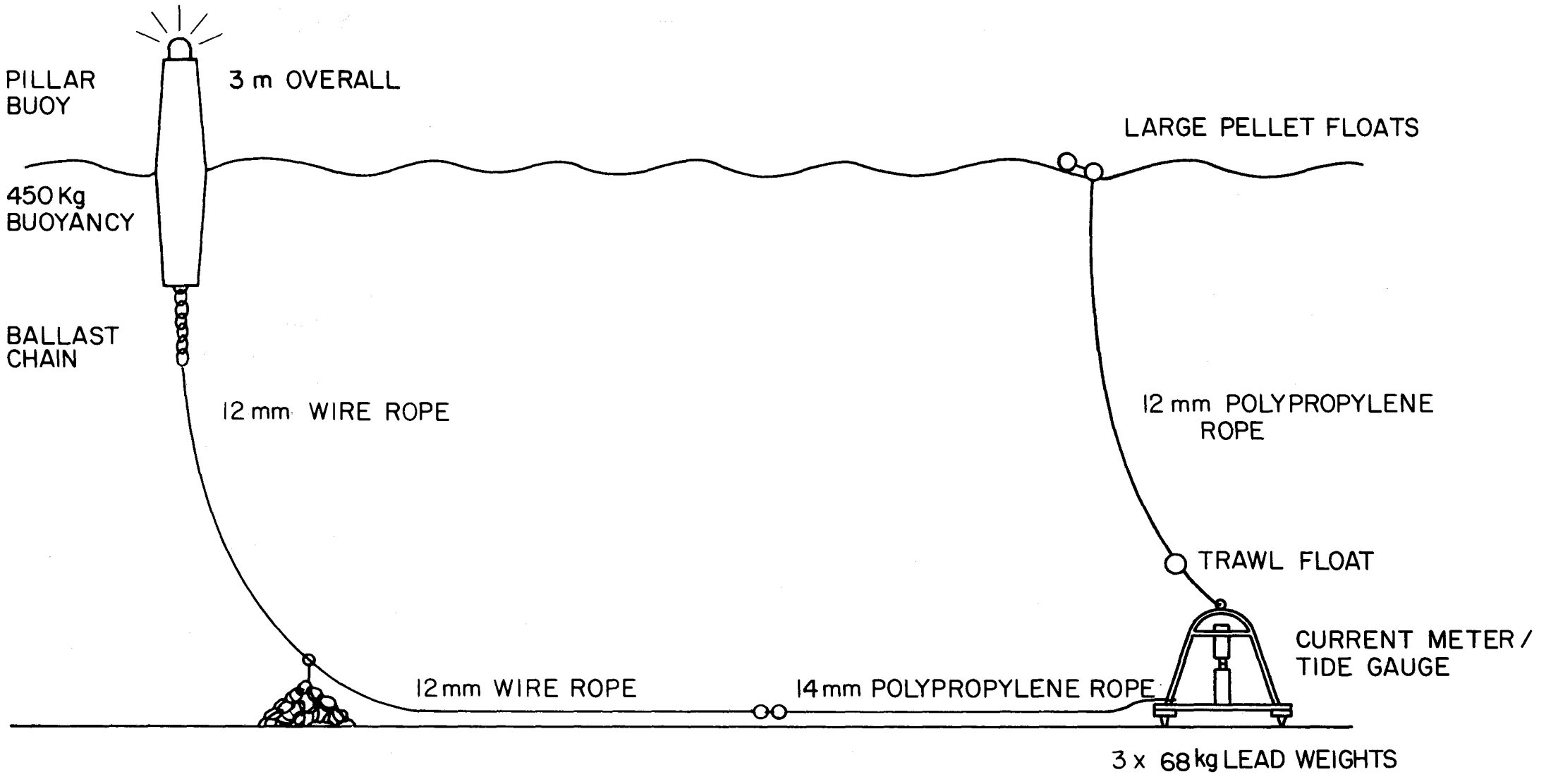


FIGURE 3

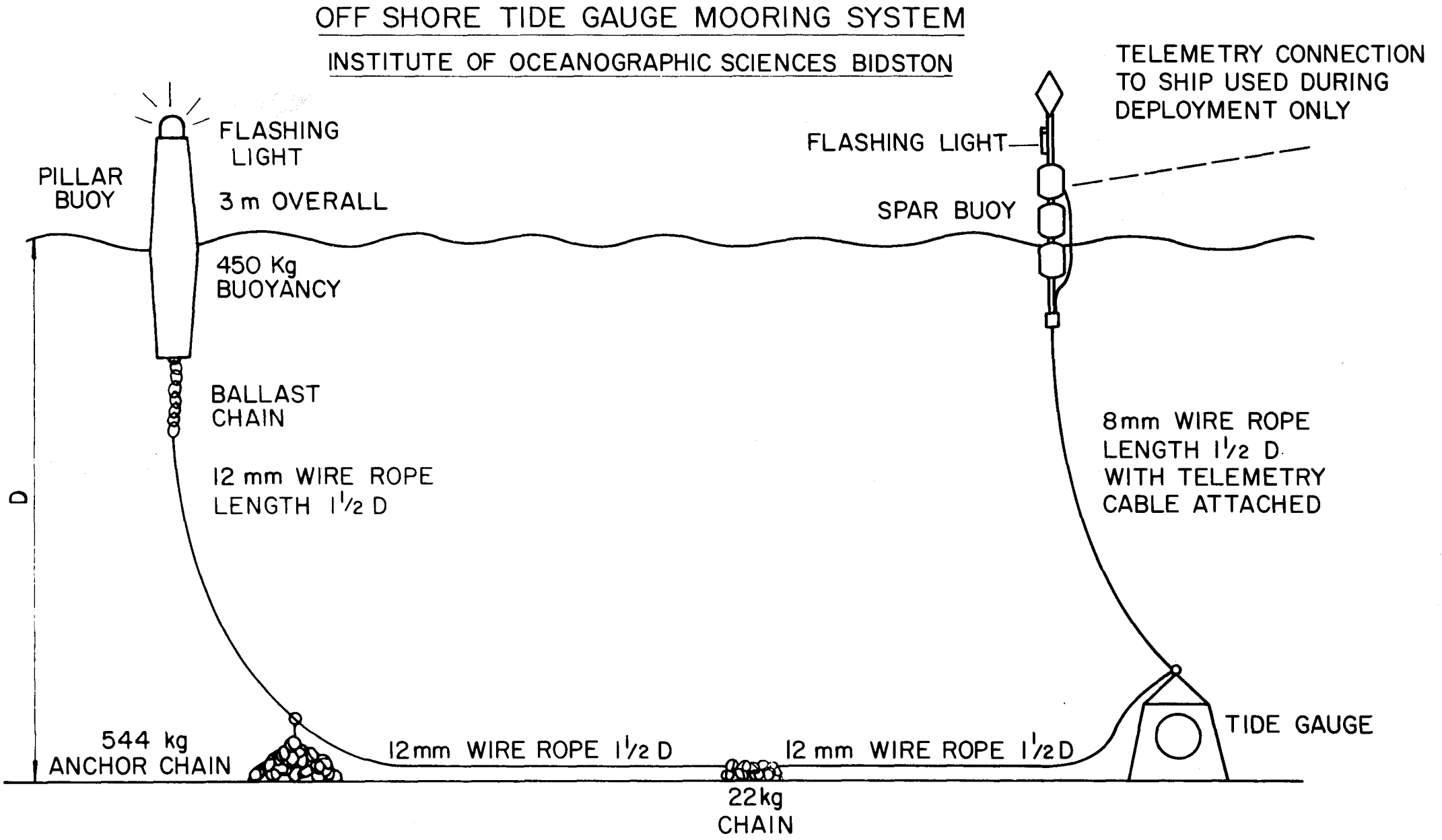

OFF SHORE TIDE GAUGE MOORING SYSTEM
INSTITUTE OF OCEANOGRAPHIC SCIENCES BIDSTON
TELEMETRY CONNECTION TO SHIP USED DURING DEPLOYMENT ONLY
FLASHING LIGHT
PILLAR BUOY
3 m OVERALL
FLASHING LIGHT
SPAR BUOY
450 Kg BUOYANCY
BALLAST CHAIN
12 mm WIRE ROPE LENGTH 1½ D
8mm WIRE ROPE LENGTH 1½ D WITH TELEMETRY CABLE ATTACHED
D
544 kg ANCHOR CHAIN
12mm WIRE ROPE 1½ D
12 mm WIRE ROPE 1½ D
TIDE GAUGE
22kg CHAIN

FIGURE 4

CURRENT METER MOORING SYSTEM

INSTITUTE OF OCEANOGRAPHIC SCIENCES, BIDSTON

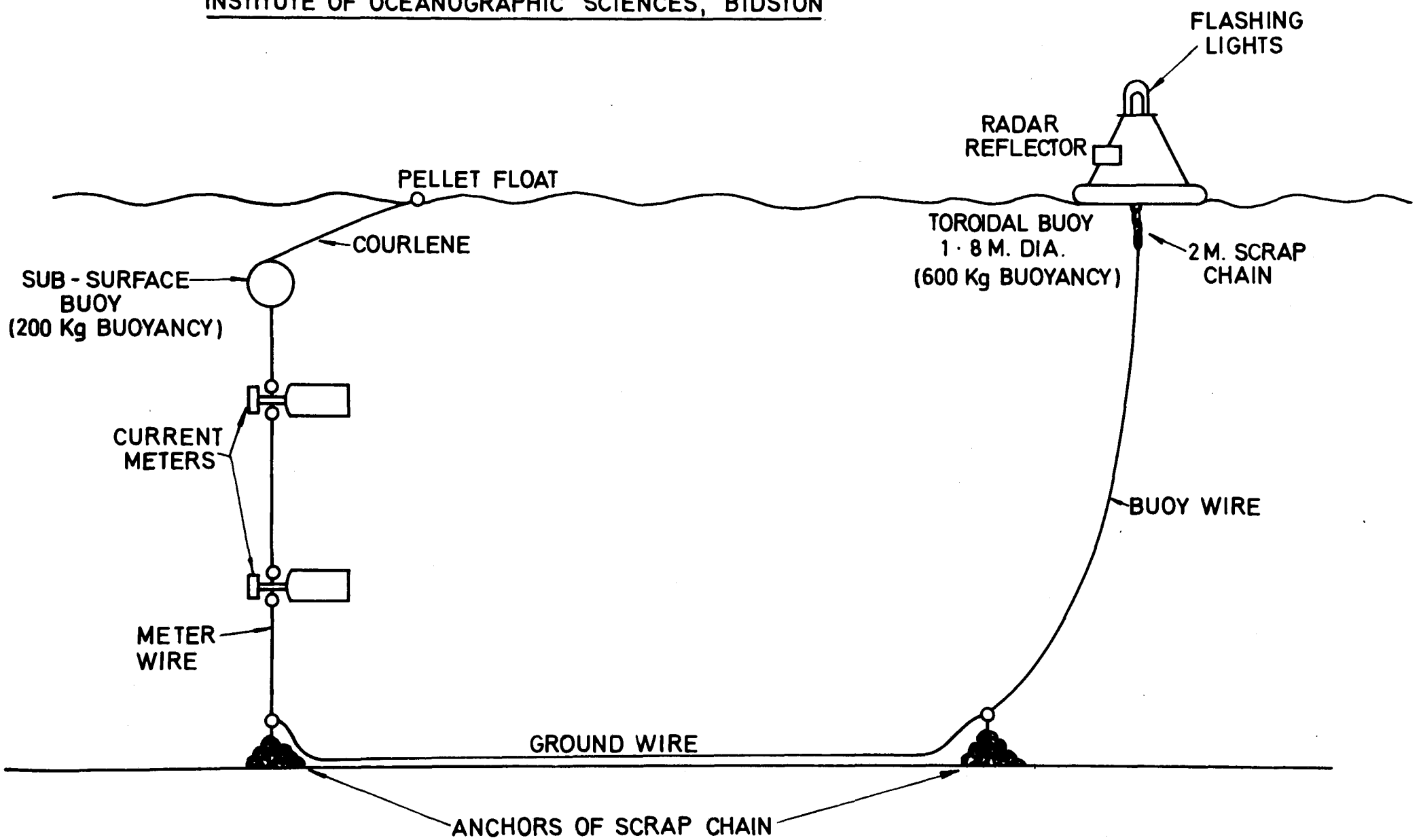


FIGURE 5

8. PRESSURE RECORD FORMAT

The report is split into sections, one for each deployment, each section comprising a page of launch and recovery details, a page of data reduction details, and the record from each sensor displayed in computer plots and tables of the tidal constituents obtained by analysis of the tidal record.

Launch and recovery details

OSTG position	Station identification, General area, Year. Latitude and Longitude. Value of g.
Water depth	Measured at Launch by PDR (Precision Depth Recorder) and/or taken from Admiralty Chart.
OSTG details	Type, Logger number, Sensor type(s) and number(s). Sampling and integration periods.
Time of launch	Time of launch of gauge from ship, time that gauge was on sea bed, and/or launch start and finish times.
Time of recovery	Time that gauge surfaced or was brought on board ship
CTD casts	Time and duration of any CTD casts on station. Value of density computed from casts.
Comments	Comments on the launch and/or recovery.

Data reduction details

Timing	Times of specific scans and timing error.
Raw data	Times of start and end of raw sea-bed pressure data .
Temperature data	Details of temperature record(s) available.
Drift-free data	Times of start and end of drift-free hourly pressure record. Method used to produce drift free data.
Tidal analysis	Method used, period analysed. Station used for related constituents .
Comments	Comments on data reduction.

Computer plots

(1) Plot of temperature record(s) if available.

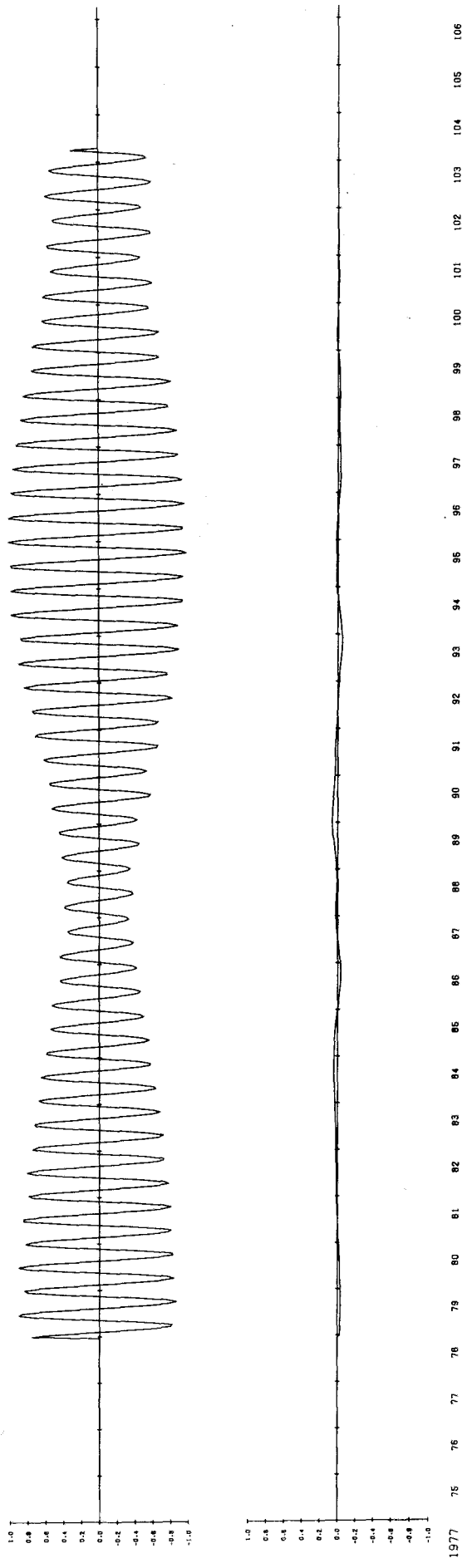
(2) Plot of tidal and non tidal components of the hourly record of sea-bed pressure data.

Analysis

Tables of amplitude and phase (G - referred to lunar transit at Greenwich and time zone S=0) of the major and related constituents of tidal record from each sensor, and the vector means if applicable.

OSTG position	Station 10, Eastern Irish Sea, 1977. Lat 53°46'N, Long 03°43'W. $g = 9.814\ ms^{-2}$.
Water depth	41m (PDR), 36m (chart).
OSTG details	Aanderaa CM/TG no. 1 consisting of Aanderaa logger no. 1747, sensor pack DIG 5/2, and current meter no. 1747/6. 600s sampling and integration periods.
Time of launch	Deployment started from RRS "John Murray" at 1904 GMT day 075 (16 March), and completed at 1916 GMT.
Time of recovery	Recovery started from RRS "John Murray" at 1042 GMT day 107 (17 April). CM/TG on deck at 1100 GMT.
CTD casts	1 cast, no. 4, at 1815 GMT day 075. 1 cast, no. 29, at 1103 GMT day 107. Density, ρ = 1026.379 Kg m^{-3}.
Comments	

Timing	Scan no. 1 at 1600,00 GMT day 062 (3 March). Scan no. 8773 at 1359,42 GMT day 123 (5 May). Clock fast, gained 18s in 60 days and 22 hours.
Raw data	Start 1924, 56 GMT day 075 (16 March). End 1034, 47 GMT day 107 (17 April).
Temperature data	Record from current meter no. 1747/6.
Drift-free data	Start 0000 GMT day 079. End 0600 GMT day 104. FHP53 filter used.
Tidal analysis	1 TIRA, 0000 GMT day 077 to 2300 GMT day 105. 29 days of unfiltered data. 2 TIRA, 0000 GMT day 086 to 2300 GMT day 100, 15 days of filtered data. 1 using 27 major and 8 related constituents, 2 using 22 major and 17 related constituents, from Hilbre Island analysis (1964/65).
Comments	



FILTERED VALUES
SCALE Y=0.41335 E03
MEAN VALUE=0.50190 E04

RESIDUALS
SCALE Y=0.41335 E03
MEAN VALUE=0.50194 E04

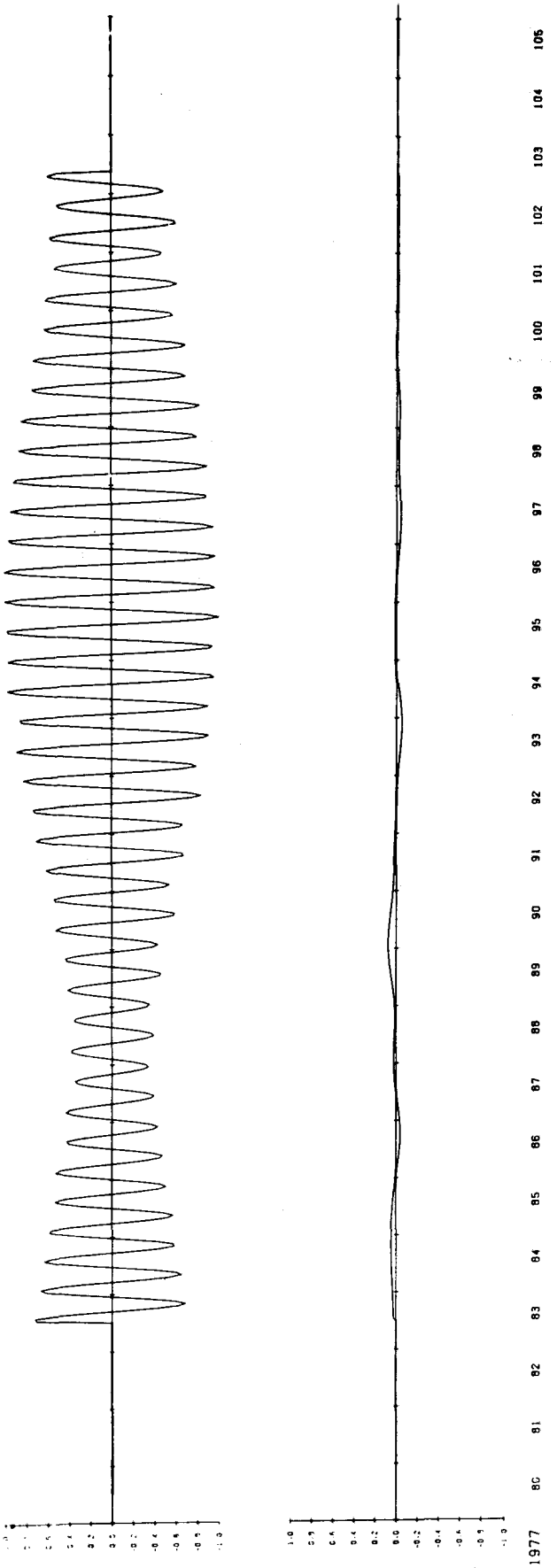
IRISH SEA 10 CM/TG 1/1747 TOTAL PRESS

Station 10, Eastern Irish Sea, 1977. Lat. 53° 46'N, Long 03° 43'W.
Aanderaa CM/TG no. 1, DIG 5/2 sensor pack.
29 days unfiltered and 15 days filtered total pressure data (millibars).
* Related constituents using Hilbre Island analysis (1964/65).

	15 Days 086 to 100, 1977				29 Days 077 to 105, 1977			
	Constituent	Related to	H(mb)	G(°)	Constituent	Related to	H(mb)	G(°)
	2Q1		0.8	57.1				
*	σ1	2Q1	0.6	292.8				
*	Q1	O1	3.8	10.8	Q1		4.7	346.5
*	ρ1	O1	0.9	343.3				
	O1		10.5	43.0	O1		12.6	44.9
*	π1	K1	0.8	86.3	M1		1.0	146.9
*	P1	K1	7.0	184.8	* π1	K1	0.6	74.4
*	S1	K1	2.7	137.5	* P1	K1	5.6	172.9
	K1		19.2	191.5	K1		15.5	179.6
*	ψ1	K1	1.6	97.5	* ψ1	K1	1.3	85.6
*	Ø1	K1	1.4	198.5	* Ø1	K1	1.1	186.6
*	J1	OO1	1.8	270.8	J1		0.2	42.0
	OO1		3.0	84.3	OO1		2.8	60.3
*	MNS2	2N2	1.3	83.5				
	2N2		11.9	273.1	* 2N2	N2	9.3	260.2
*	μ2	2N2	3.6	58.5	μ2		0.8	78.9
*	N2	M2	50.9	295.0	N2		51.2	293.5
*	ν2	M2	10.8	293.6	* ν2	N2	10.9	292.1
	M2		263.9	318.2	M2		265.8	317.9
*	L2	M2	12.0	332.1	L2		10.2	309.0
*	T2	S2	5.1	0.9	* T2	S2	5.0	357.9
	S2		86.6	2.1	S2		85.7	359.1
*	K2	S2	25.4	0.4	* K2	S2	25.1	357.4
*	MSN2	2SM2	3.5	227.7	2SM2		3.9	234.6
	2SM2		4.4	228.1				
	MO3		2.4	222.1	MO3		0.6	201.8
	M3		2.0	256.5	M3		3.1	287.4
	MK3		1.5	49.8	MK3		0.3	60.4
	MN4		3.1	137.1	MN4		4.3	191.6
	M4		16.1	199.6	M4		11.6	204.4
	SN4		3.5	80.1	SN4		1.6	174.5
	MS4		9.1	235.5	MS4		7.7	244.9
	2MN6		0.5	213.3	2MN6		0.7	3.2
	M6		3.2	335.1	M6		1.4	12.0
	MSN6		1.7	165.0	MSN6		0.6	14.2
	2MS6		1.7	7.7	2SM6		1.6	48.0
	2SM6		0.3	55.7	2SM6		0.4	69.4

OSTG position	Station 12, Eastern Irish Sea, 1977. Lat 53°46'N, Long 04°08'W. $g = 9.814\ ms^{-2}$.
Water depth	48m (PDR), 41m (chart).
OSTG details	Aanderaa CM/TG no. 2 consisting of Aanderaa logger no. 1507, sensor pack DIG 5/1, and current meter no. 1507/2. 600s sampling and integration periods.
Time of launch	Deployment started from RRS "John Murray" at 0946 GMT day 078 (19 March), and completed at 1145 GMT.
Time of recovery	Recovery started from RRS "John Murray" at 0526 GMT day 108 (18 April). CM/TG on deck at 0544 GMT.
CTD casts	1 cast, no. 6, at 2317 GMT day 075. 1 cast, no. 8, at 0935 GMT day 078. 1 cast, no. 32, at 0500 GMT day 108. Density, ρ = 1026.881 kg m^{-3}
Comments	Experimental current meter with optical vane follower was deployed at this station at 0633 GMT day 107 and recovered 0640 GMT day 108.

Timing	Scan no. 1 at 1130,00s GMT day 063 (4 March). Scan no. 8770 at 0859,50s GMT day 124 (4 May). Clock fast, gained 10s in 60 days and 21½ hours.
Raw Data	Start 0744,57s GMT day 080 (21 March). End 1224,53s GMT day 106 (16 April). See Comments.
Temperature data	Record from current meter no. 1507/2.
Drift-free data	Start 1300 GMT day 083. End 0800 GMT day 103. FHP53 filter used.
Tidal Analaysis	TIRA, 0000 GMT day 086 to 2300 GMT day 100, 15 days of filtered data. 2 major and 8 related constituents from Hilbre Island analysis (1964/65).
Comments	There were 8 discontinuities, due to rig movement, in the first 2 days record and 4 in the last 1½ days record, therefore the record was truncated at beginning and end. First and last usable scans were seabed scans no. 264 and 4036 respectively. Two further discontinuities on day 092 were smoothed manually.



FILTERED VALUES
SCALE Y=0.37092 E03
MEAN VALUE=0.55898 E04

RESIDUALS
SCALE Y=0.37092 E03
MEAN VALUE=0.55892 E04

IRISH SEA 12 CM*TG 2 1507 TOTAL PRESS

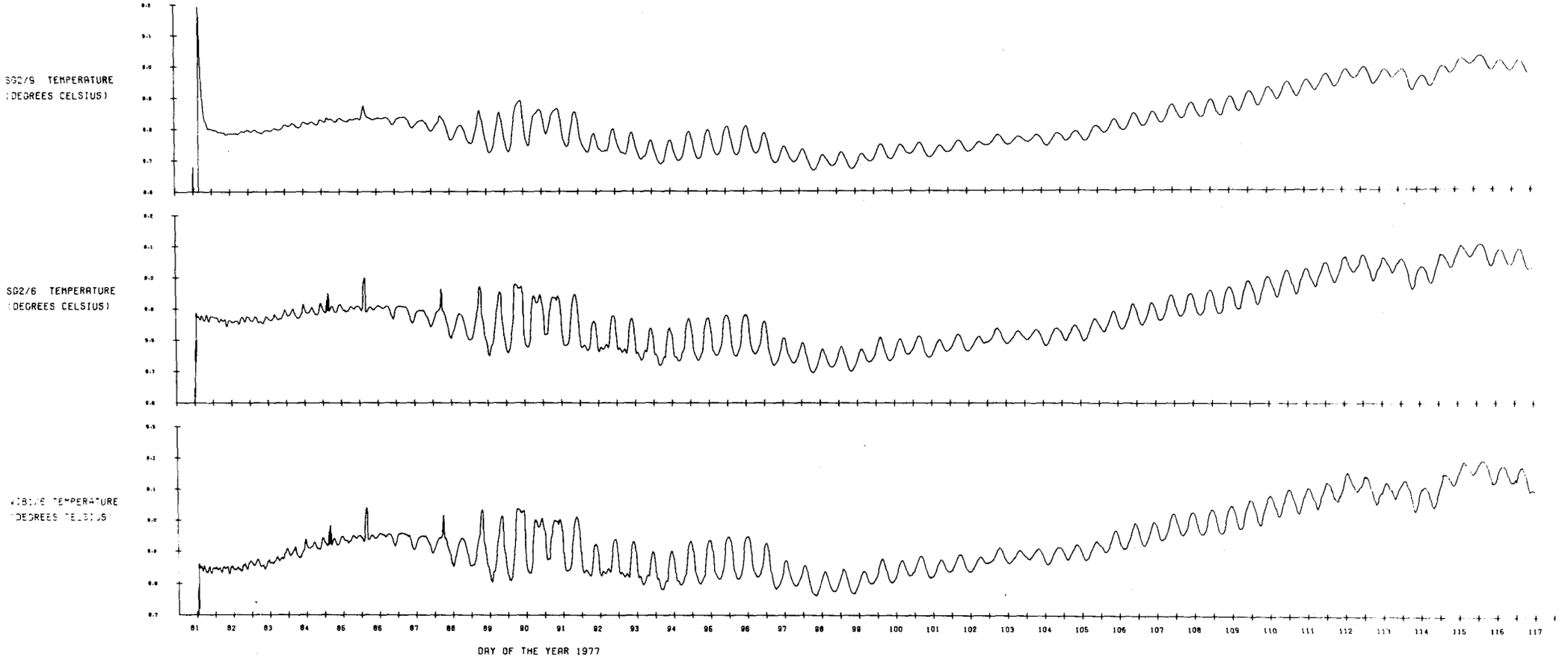
Station 12, Eastern Irish Sea, 1977. Lat 53° 46'N, Long 04° 08'W.
Aanderaa CM/TG no. 2, DIG 5/1 sensor pack.
15 days filtered total pressure data (millibars).
*Related constituents using Hilbre Island analysis. (1964/65).

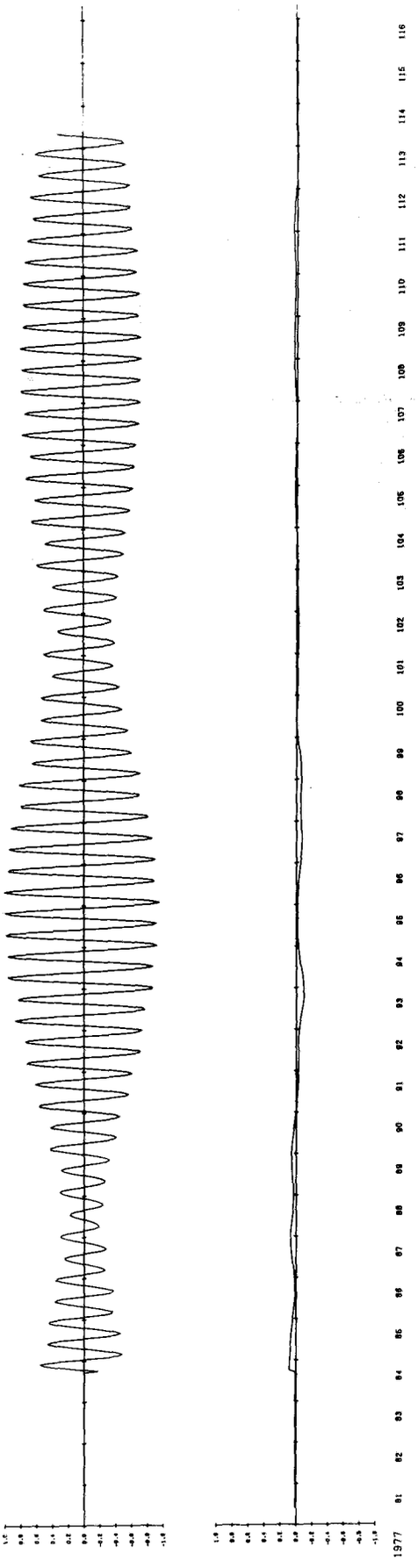
	Days 086 to 100, 1977 Constituent	related to	H(mb)	G(°)
	2Q1		0.7	52.3
*	σ1	2Q1	0.5	288.0
*	Q1	O1	3.8	11.7
*	ρ1	O1	0.9	344.2
	O1		10.3	43.9
*	π1	K1	0.8	86.9
*	P1	K1	6.9	185.4
*	S1	K1	2.7	138.1
	K1		19.0	192.1
*	ψ1	K1	1.5	98.1
*	Ø1	K1	1.4	199.1
*	J1	OO1	1.9	276.7
	OO1		3.1	90.2
*	MNS2	2N2	1.4	84.7
	2N2		12.1	274.3
*	μ2	2N2	3.7	59.7
*	N2	M2	45.8	293.5
*	ν2	M2	9.7	292.1
	M2		237.7	316.7
*	L2	M2	10.8	330.6
*	T2	S2	4.5	358.6
	S2		77.2	359.8
*	K2	S2	22.6	358.1
*	MSN2	2SM2	3.0	229.2
	2SM2		3.8	229.6
	MO3		1.6	221.3
	M3		1.7	251.7
	MK3		1.1	46.6
	MN4		1.5	133.1
	M4		9.7	194.9
	SN4		2.1	61.1
	MS4		5.4	231.2
	2MN6		0.5	167.1
	M6		1.5	302.2
	MSN6		1.1	141.8
	2MS6		0.7	329.1
	2SM6		0.1	18.0

OSTG position	Station 33, Irish Sea (St. George's Channel), 1977. Lat 52°04'n, Long 05°47'W. g = 9.813 ms^{-2}.
Water depth	95m (PDR) 94m (chart).
OSTG details	Mk II, Logger no. 05, sensors VIB 1/6, SG 2/6, SG 2/9. 900s sampling and 899.944s integration periods. See comments.
Time of launch	Deployment started from RRS "John Murray" at 1251 GMT day 081 (22 March). Tide gauge on sea bed at 1315 GMT.
Time of recovery	Recovery started from RRS "John Murray" at 1058 GMT day 117 (27 April). Tide Gauge on deck at 1300 GMT. See Comments.
CTD casts	1 cast, no. 17, at 1252 GMT day 081. 1 cast, no. 50, at 1350 GMT, day 117 Density, ρ = 1026.896 Kg m^{-3}.
Comments	SG 2/6 is Bell Howell type 4-306 with improved electronics but in old case. SG 2/9 is Bell and Howell type 4-800 twin film transducer in Aanderaa case. Both surface buoys missing, therefore OSTG recovered by dragging, no damage to OSTG or to frame.

Timing	Scan no. 1 at 1600,05s GMT day 059 (28 February) Scan no. 5562 at 1415,14s GMT day 117 (27 April). Clock slow, lost 9s in 57 days and 22¼ hours.
Raw data	Start 1337,38s GMT day 081 (22 March) End 1222,44s GMT day 117 (27 April) See Comments.
Temperature data	Complete temperature records from all 3 sensors.
Drift free data	Start 1800 GMT day 084 End 0800 GMT day 114. FHP 53 filter used.
Tidal analysis	TIRA, 0020 GMT day 085 to 2300 GMT day 113, 29 days (filtered data). 27 major and 8 related constituents from Fishguard analysis (1963).
Comments	Pressure data from SG 2/6 very noisy and fell to zero for 7 hours from 0630 day 090, then returned to higher DC level, therefore not processed.

OSTG MK11 OS MARCH/APRIL 1977
IRISH SEA STATION 33 (J) 52 04N 05 47W

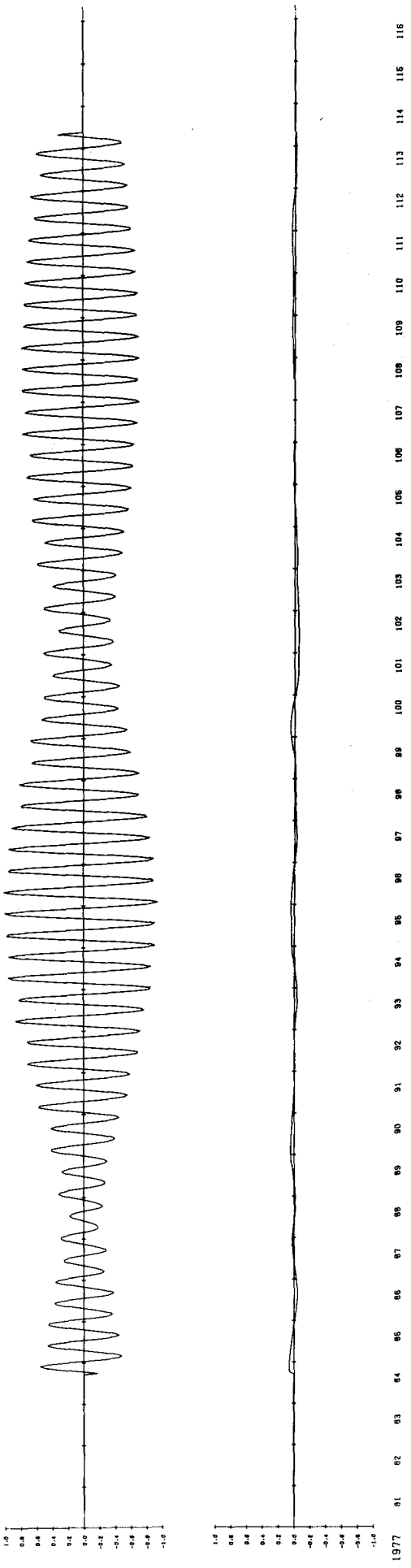




FILTERED VALUES
SCALE Y=0.19860 E03
MEAN VALUE=0.10867 E06

RESIDUALS
SCALE Y=0.19860 E03
MEAN VALUE=0.10856 E06

IRISH SEA 33 (J) VIB1/6 TOTAL PRESSURE



FILTERED VALUES
SCALE Y=0.20084 E03
MEAN VALUE=0.10660 E05

RESIDUALS
SCALE Y=0.20084 E03
MEAN VALUE=0.10649 E05

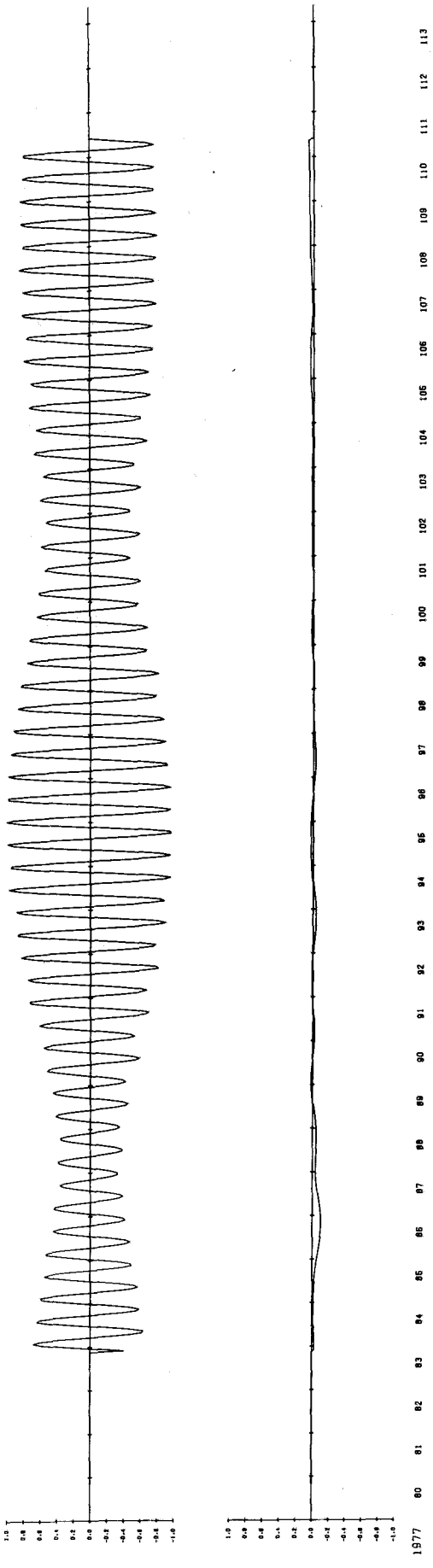
IRISH SEA 33 (J) SG2/9 TOTAL PRESSURE

Station 33, Irish Sea (St. George's Channel), 1977, Lat 52°04'N Long 05°47'W.
O.S.T.G. Mk II, Logger 05.
29 days of filtered total pressure data (millibars).
*Related constituents using Fishguard analysis (1963).
0000 GMT day 085 to 2300 GMT day 113, 1977.

Constituent	related to	VIB 1/6 H(mb)	VIB 1/6 G(°)	SG 2/9 H(mb)	SG 2/9 G(°)	Vector Mean H(mb)	Vector Mean G(°)
Q1		2.1	335.7	2.3	334.2	2.20	335.0
O1		7.9	32.2	8.2	29.0	8.05	30.6
M1		0.8	62.8	0.6	51.3	0.70	57.9
π1*	K1	0.2	332.4	0.2	330.4	0.20	331.4
P1*	K1	2.9	150.3	2.8	148.3	2.85	149.4
K1		7.9	156.5	7.7	154.5	7.80	155.6
ψ1*	K1	0.6	116.7	0.6	114.7	0.60	115.7
Ø1*	K1	0.3	248.7	0.3	246.7	0.30	247.7
J1		0.7	14.6	0.6	19.9	0.65	17.1
OO1		1.1	22.2	0.8	22.2	0.95	22.2
2N2*	N2	2.8	162.8	2.8	163.2	2.80	163.0
μ2		6.2	203.5	6.3	204.9	6.25	204.3
N2		21.7	170.9	21.8	171.3	21.75	171.2
ν2*	N2	3.4	160.3	3.4	160.7	3.40	160.5
M2		111.1	183.9	112.1	183.7	111.60	183.8
L2		4.8	94.2	5.0	92.6	4.90	93.4
T2*	S2	2.4	235.4	2.4	235.6	2.40	235.5
S2		43.7	229.4	44.3	229.7	44.00	229.6
K2*	S2	12.6	228.6	12.8	228.8	12.70	228.8
2SM2		1.4	47.5	1.4	49.6	1.40	48.6
MO3		0.5	48.5	0.6	49.0	0.55	48.8
M3		0.8	155.6	0.7	160.0	0.75	157.7
MK3		0.1	150.0	0.2	135.1	0.15	140.1
MN4		1.4	357.1	1.5	1.9	1.45	359.6
M4		3.6	18.7	4.0	18.7	3.80	18.8
SN4		0.7	324.6	0.6	318.4	0.65	321.8
MS4		1.7	44.3	2.0	46.1	1.85	45.3
2MN6		0.3	164.4	0.3	164.2	0.30	164.3
M6		0.3	211.8	0.3	214.2	0.30	213.0
MSN6		0.3	317.1	0.3	313.7	0.30	315.4
2MS6		0.8	268.1	0.8	264.1	0.80	266.1
2SM6		0.4	352.9	0.4	0.3	0.40	356.6

OSTG position	Station 34, Eastern Irish Sea, 1977. Lat 54° 09'N, Long 03°40'W. g = 9.814 ms-2.
Water depth	29m (PDR), 31m (chart).
OSTG details	Aanderaa OSTG type 2A/64. 900s sampling 104 seconds integration period.
Time of launch	Deployment started from RRS "John Murray" at 1658 GMT day 080 (21 March), and completed at 1715 GMT.
Time of recovery	Recovery started from RRS "John Murray" at 1333 GMT day 114 (24 April). Tide gauge on deck at 1404 GMT.
CTD casts	1 cast, no. 16, at 1640 GMT day 080 1 cast, no. 46, at 1425 GMT day 114 Density, ρ = 1025.813 Kg m^{-3}.
Comments	

Timing	Scan no.1 at 0859,59 GMT day 062 (3 March) Scan no.5785 at 1456,57 GMT day 122 (2 May) Clock fast, gained 62s in 60 days and 6 hours.
Raw data	Start 1728,48 GMT day 080 (21 March). End 1328,13 GMT day 114 (24 April).
Temperature data	No temperature sensor.
Drift free data	Start 2200 GMT day 083. End 0900 GMT day 111. FHP 53 filter used.
Tidal Analysis	TIRA, 2200 GMT day 083 to 0900 GMT day 111, 27 days and 11 hours of filtered total pressure data. 27 major and 8 related constituents from Heysham (1964).
Comments	



FILTERED VALUES
SCALE Y=0.41186 E03
MEAN VALUE=0.44136 E04

RESIDUALS
SCALE Y=0.41186 E03
MEAN VALUE=0.44131 E04

IRISH SEA 34 OSTG 2A/64 TOTAL PRESSURE

Station 34, Eastern Irish Sea, Lat 54°09', Long 03°40'W.
Aanderaa O.S.T.G. 2A/64.
27 days and 12 hours of filtered total pressure data (millibars).
*Related constituents using Heysham analysis (1964).

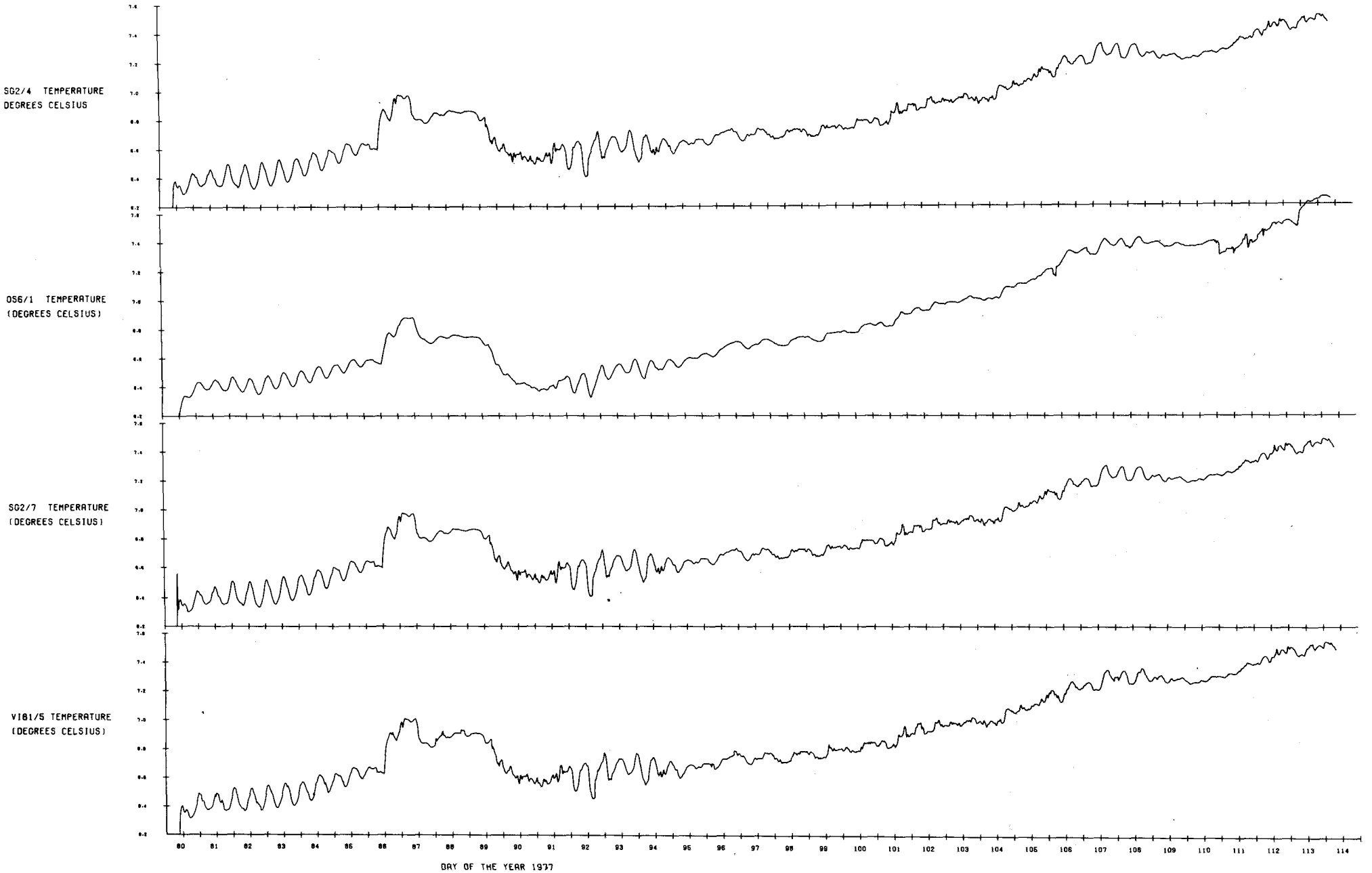
2200 GMT day 083 to 0900 GMT day 111.

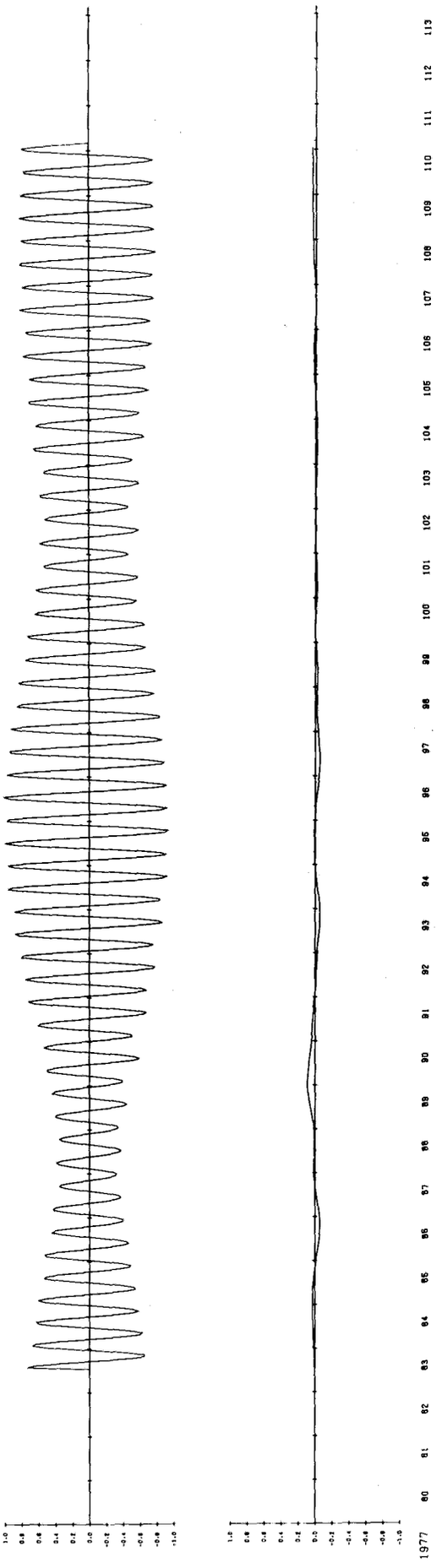
	Constituent	related to	H(mb)	G(°)
	Q1		5.2	353.8
	O1		12.7	47.6
	M1		1.5	169.1
*	π1	K1	1.6	101.9
*	P1	K1	6.5	175.3
	K1		17.6	186.9
*	ψ1	K1	1.8	80.1
*	Ø1	K1	1.6	184.0
	J1		1.9	37.8
	OO1		2.8	44.1
*	2N2	N2	9.8	264.9
	μ2		2.3	48.0
	N2		51.6	300.3
*	ν2	N2	10.5	299.2
	M2		265.3	324.7
	L2		10.5	316.9
*	T2	S2	5.4	358.9
	S2		84.8	6.2
*	K2	S2	25.0	5.7
	2SM2		3.5	240.7
	MO3		0.8	196.3
	M3		2.7	299.6
	MK3		0.4	14.7
	MN4		4.2	204.1
	M4		11.5	216.8
	SN4		1.4	183.1
	MS4		7.1	254.3
	2MN6		0.4	353.4
	M6		0.8	6.8
	MSN6		0.4	339.7
	2MS6		0.9	33.9
	2SM6		0.3	29.0

OSTG position	Station 35, Solway Firth, 1977. Lat 53°39'N, Long 03°55'W. $g = 9.815\ ms^{-2}$.
Water depth	32m (PDR), 31m (chart).
OSTG details	Mk II, logger no. 002, sensors VIB 1/5, SG 2/7, DS 6/1, SG 2/8, SG 2/4. 900s sampling and 899.994s integration periods. See Comments.
Time of launch	Deployment started from RRS "John Murray" at 0940 GMT day 080 (21 March).
Time of recovery	Recovery started from RRS "John Murray" at 0856 GMT day 114 (24 April). Tide gauge on deck at 0917 GMT.
CTD casts	1 cast, no. 15, at 0800 GMT day 080. 1 cast, no. 45, at 0926 GMT day 114. Density, $\rho = 1025.893\ Kgm^{-3}$.
Comments	SG 2/4 sensors housed in old style case. SG 2/7 and SG 2/8 sensors housed in Aanderaa current meter type case. DS 6/1 is Digiquartz depth sensor housed in Aanderaa current meter type case.

Timing	Scan no. - 559 at 1615,03 GMT day 056 (25 Feb.). Scan no. 4986 at 1014,49 GMT day 114 (24 April) Clock fast, gained 14s in 57 days and 18 hours.
Raw data	Start 0952,27 GMT day 080 (21 March) End 0852,19 GMT day 114 (24 April). See Comments.
Temperature data	Complete temperature records from all sensors except SG 2/8.
Drift free data	Start 1400 GMT day 083. End 0400 GMT day 111. FHP53 filter used.
Tidal analysis	TIRA, 1400 GMT day 083 to 0400 GMT day 111, 27 days and 15 hours of filtered total pressure. 27 major and 8 related constituents using Workington (1975/76).
Comments	No data from SG 2/8 due to sensor output failure.

OSTG MKII 02 MARCH/APRIL 1977
IRISH SEA STATION 36 54 39N 03 55W

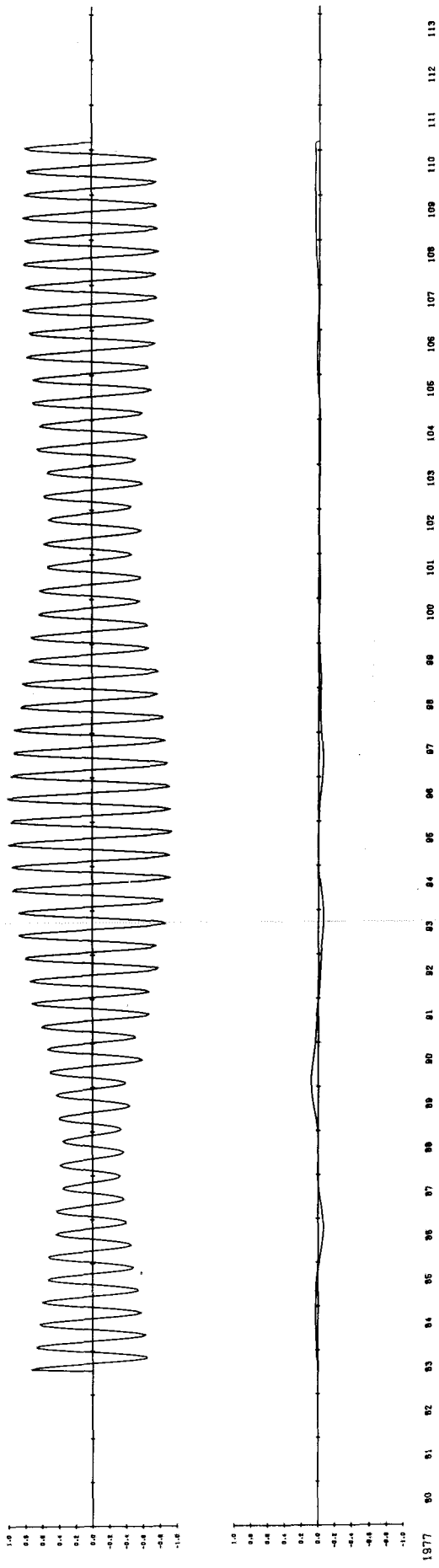




FILTERED VALUES
SCALE Y=0.40938 E03
MEAN VALUE=0.43690 E04

RESIDUALS
SCALE Y=0.40938 E03
MEAN VALUE=0.43677 E04

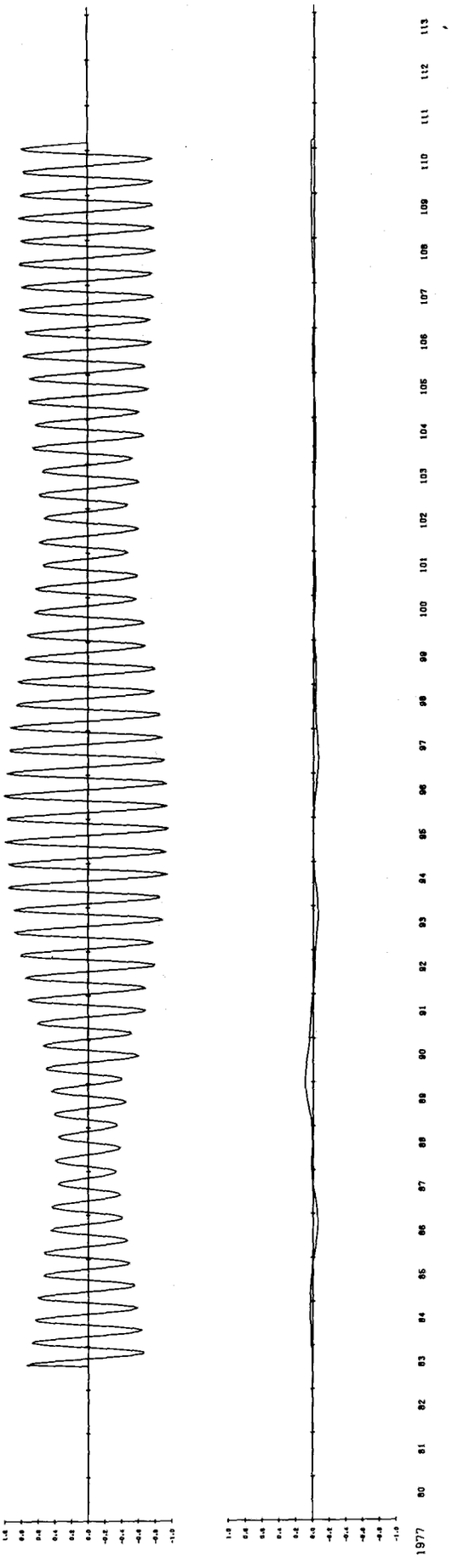
IRISH SEA 35 VIB175 TOTAL PRESSURE



FILTERED VALUES
SCALE Y=0.40891 E03
MEAN VALUE=0.42220 E04

RESIDUALS
SCALE Y=0.40891 E03
MEAN VALUE=0.42206 E04

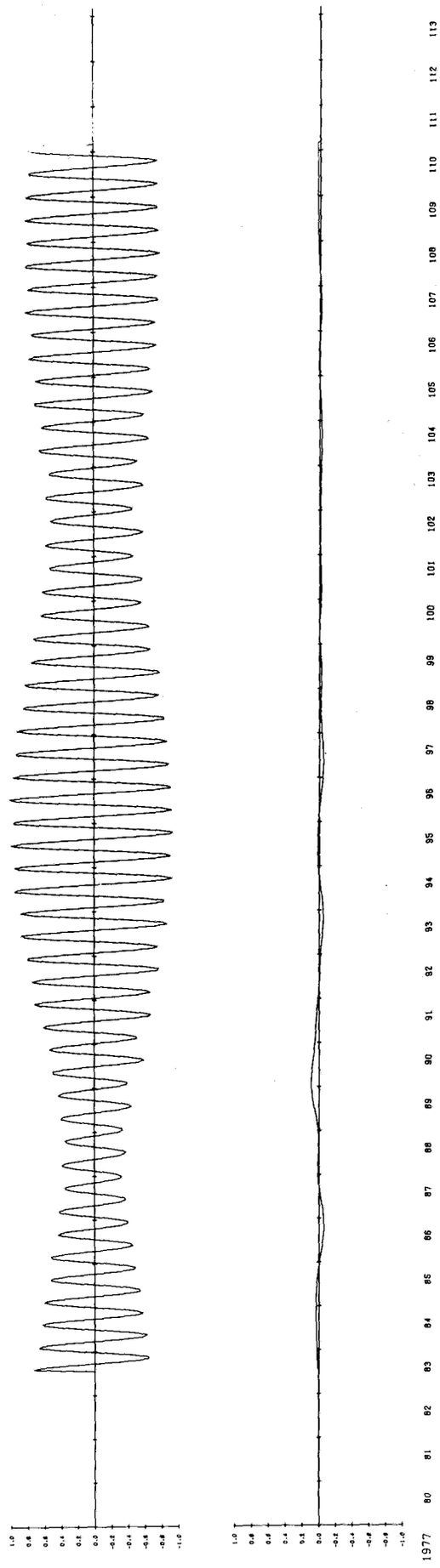
IRISH SEA 35 SG2/7 TOTAL PRESSURE



FILTERED VALUES
SCALE Y=0.40061 E03
MEAN VALUE=0.43440 E04

RESIDUALS
SCALE Y=0.40061 E03
MEAN VALUE=0.43417 E04

IRISH SEA 35 DS6/1 TOTAL PRESSURE



FILTERED VALUES
SCALE Y=0.40978 E03
MEAN VALUE=0.42808 E04

RESIDUALS
SCALE Y=0.40978 E03
MEAN VALUE=0.42788 E04

IRISH SEA 35 SG2/4 TOTAL PRESSURE

Station 35, Solway Firth, 1977. Lat 54° 39'N, Long 03°55'W.
O.S.T.G. Mk II, Logger 002.
27 days and 15 hours of filtered total pressure data. (millibars).
*Related constituents using Workington analysis (1975/76).

		1400 GMT day 083 to 0400 GMT day 111 1977.							
		DS6/1		SG2/4		SG2/7		VIB1/5	
Constituent	related to	H(mb)	G(°)	H(mb)	G(°)	H(mb)	G(°)	H(mb)	G(°)
Q1		4.6	0.5	4.7	0.9	4.7	0.3	4.7	0.8
O1		12.6	50.3	12.7	50.5	12.6	50.5	12.7	50.7
M1		0.8	159.7	0.9	164.5	0.8	155.6	0.8	159.4
π1*	K1	0.6	174.5	0.6	175.8	0.6	175.2	0.6	174.9
P1*	K1	4.6	179.5	4.6	180.8	4.7	180.2	4.6	179.9
K1		14.6	186.3	14.7	187.6	14.7	187.0	14.6	186.7
ψ1*	K1	0.8	101.1	0.8	102.4	0.8	101.8	0.8	101.5
Ø1*	K1	0.2	109.2	0.2	110.5	0.3	109.9	0.2	109.6
J1		1.1	67.3	1.1	61.9	1.1	65.8	1.1	65.6
001		2.5	63.8	2.5	60.0	2.5	63.1	2.5	63.5
2N2*	N2	4.5	279.4	4.5	279.2	4.5	279.3	4.5	279.4
μ2		4.1	144.6	3.9	146.6	4.0	147.2	4.0	146.1
N2		50.5	307.5	50.9	307.3	50.7	307.4	50.9	307.5
ν2*	N2	11.5	313.3	11.6	313.1	11.6	313.2	11.6	313.3
M2		254.9	332.8	257.5	332.8	257.4	332.8	257.5	332.8
L2		10.7	322.5	10.8	322.7	10.7	322.7	10.8	322.7
T2*	S2	3.7	30.6	3.8	30.5	3.7	30.5	3.8	30.5
S2		83.0	16.6	84.0	16.5	83.9	16.5	84.0	16.5
K2*	S2	23.4	13.4	23.7	13.3	23.7	13.3	23.7	13.3
2SM2		3.5	250.2	3.5	249.2	3.4	250.9	3.5	249.7
O3		0.4	230.1	0.2	229.9	0.2	218.1	0.3	238.2
M3		1.7	329.4	1.7	330.3	1.7	330.1	1.7	330.5
MK3		0.3	44.8	0.3	49.9	0.3	51.0	0.3	61.9
MN4		3.8	227.3	4.1	233.8	4.2	234.9	4.1	233.6
M4		10.4	240.4	11.2	247.0	11.2	246.8	11.1	246.9
SN4		1.1	200.4	1.2	209.5	1.3	211.6	1.2	208.2
MS4		5.7	281.6	6.3	289.8	6.3	289.5	6.3	290.0
2MN6		0.3	195.3	0.4	211.9	0.4	208.1	0.4	209.5
M6		0.4	222.9	0.7	234.0	0.6	235.1	0.7	232.8
MSN6		0.5	250.5	0.6	251.4	0.6	249.2	0.6	250.5
2MS6		0.7	268.7	0.9	276.4	0.9	276.3	0.9	275.2
2SM6		0.3	278.0	0.4	290.1	0.4	286.6	0.4	286.3

See over for vector mean.

Station 35, Solway Firth, 1977. Lat 54°39'N, Long 03°55'W.
O.S.T.G. Mk II, logger 002.
27 days and 15 hours of filtered total pressure data. (millibars).
*Related constituents using Workington analysis (1975/76).

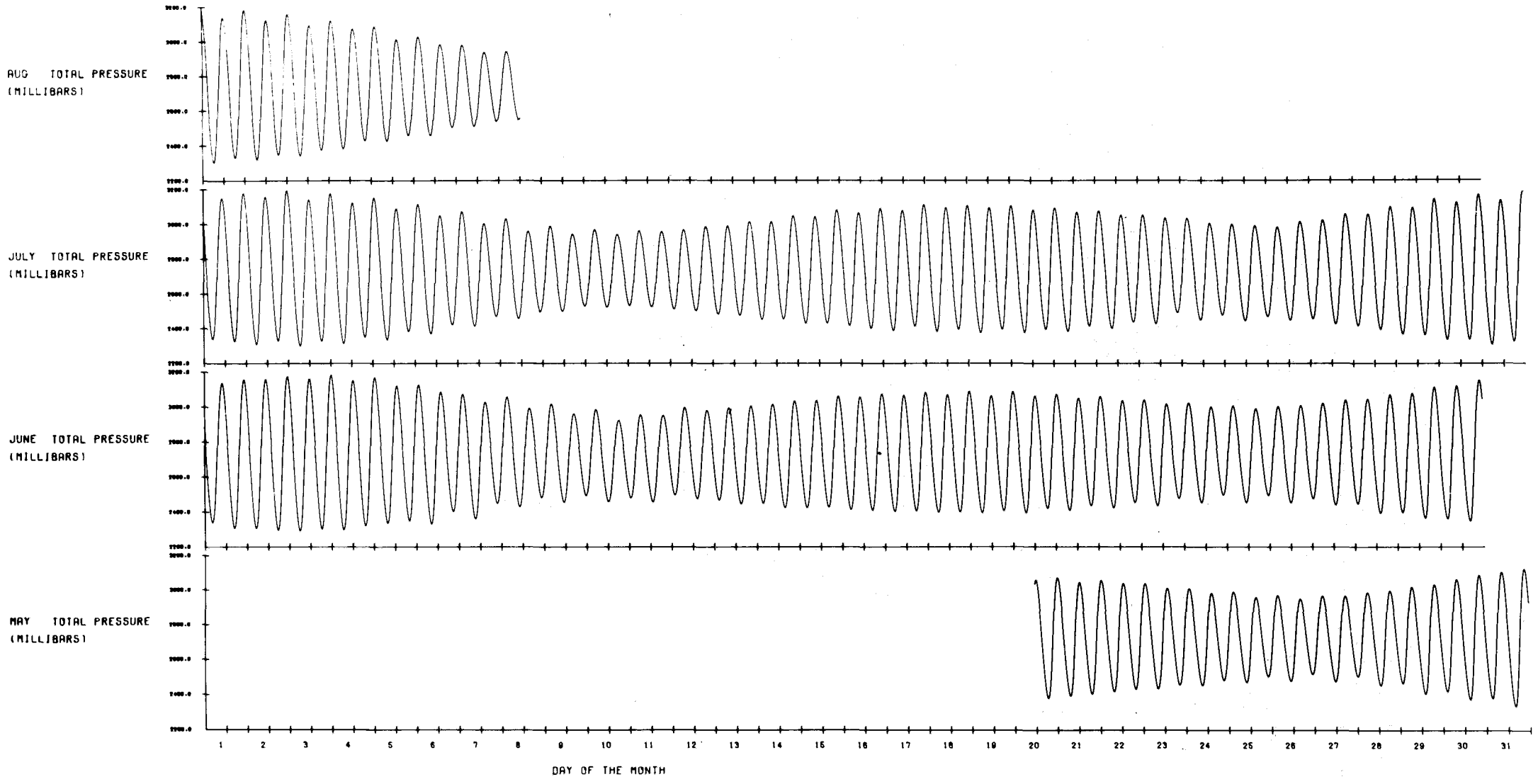
1400 GMT day 083 to 0400 GMT day 111 1977.
Vector mean of SG 2/4, SG 2/7, VIB 1/5 analyses.

Constituent	related to	H(mb)	G(°)
Q1		4.7	0.7
O1		12.7	50.6
M1		0.8	160.0
* π1	K1	0.6	175.3
* P1	K1	4.6	180.4
K1		14.7	187.2
* ψ1	K1	0.8	102.0
* Ø1	K1	0.3	110.0
J1		1.1	64.5
001		2.5	62.3
*2N2	N2	4.5	279.3
μ2		4.0	146.7
N2		50.8	307.4
* ν2	N2	11.6	313.2
M2		257.4	332.8
L2		10.8	322.7
* T2	S2	3.8	30.6
S2		84.0	16.6
* K2	S2	23.7	13.4
2SM2		3.5	250.0
MO3		0.2	230.0
M3		1.7	330.3
MK3		0.3	54.1
MN4		4.1	234.2
M4		11.2	246.9
SN4		1.2	209.8
MS4		6.3	289.8
2MN6		0.4	209.8
M6		0.7	234.0
MSN6		0.6	250.4
2MS6		0.9	276.0
2SM6		0.4	287.7

OSTG position	Queens Channel, Liverpool Bay, 1977. Lat $53^{o}30.8'N$, Long $03^{o}11.9W$. $g = 9.814\ ms^{-2}$.
Water depth	20m (PDR). 19m (chart).
OSTG details	Aanderaa OSTG type 2A, S/N 64. 900s sampling and 104s integration period.
Time of launch	Deployment started from MV "Salvor" at 1045 GMT day 140 (20 May). Tide gauge in water at 1053 GMT and on sea bed at 1055 GMT.
Time of recovery	Recovery started from MV "Salvor" at 1210 GMT day 220 (8 August). Tide gauge on deck at 1229 GMT.
CTD casts	None. 10 sea surface temperature and density casts taken between 23 May and 29 July. Density, ρ = 1025.300 KGm^{-3}.
Comments	This tide gauge was deployed for the Mersey Docks and Harbour Company as part of an investigation into off-shore and on shore tidal levels in Liverpool Bay.

Timing	Scan no. 1 at 1359,50 GMT day 139 (19 May). Scan no. 7861 at 1059,35 GMT day 221 (9 August). Clock fast, gained 15s in 81 days and 21 hours.
Raw data	Start 1128,48 GMT day 140 (20 May). End 1213,43 GMT day 220 (8 August).
Temperature data	No temperature sensor.
Hourly data	Start 1600 GMT day 140. End 1800 GMT day 220. See Comments.
Tidal Analysis	TIRA, 0000 GMT day 152 to 2300 GMT day 180, and 0000 GMT day 182 to 2300 GMT day 210, 29 days of sea level data. 27 Major and 8 related constituents using Hilbre Island analysis (1964/65).
Comments	The total pressure data were reduced to sea level data by subtracting hourly atmospheric pressure at Bidston (reduced to Mean Sea Level) and using the hydrostatic relation. The resulting series was reduced to Admiralty Chart Datum using corrections for the height of the sensor orifice above the tide gauge frame base and the difference between the sensor level and Hilbre Island datum, using the Admiralty method of equating Mean Sea Level.

OSTG AANDERAA 2A/64 MAY/AUGUST 1977
LIVERPOOL BAY QUEENS CHANNEL



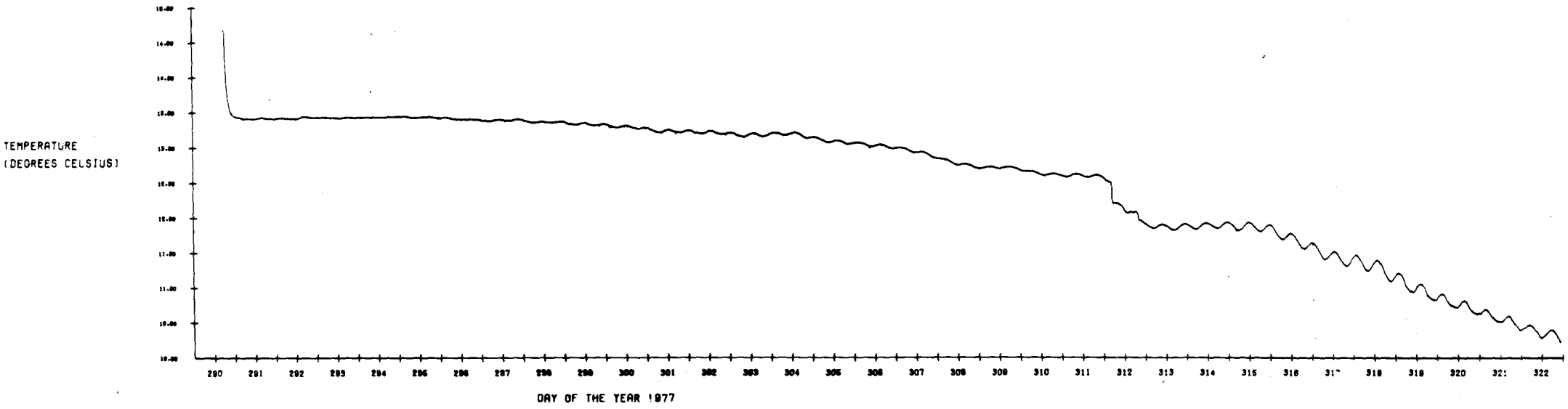
Queens Channel, Liverpool Bay, 1977. Lat 53°30.8'N, Long 03°11.9'W
Aanderaa O.S.T.G. 2A/64.
29 days of sea level data. (metres)
*Related constituents using Hilbre Island analysis (1964/65).

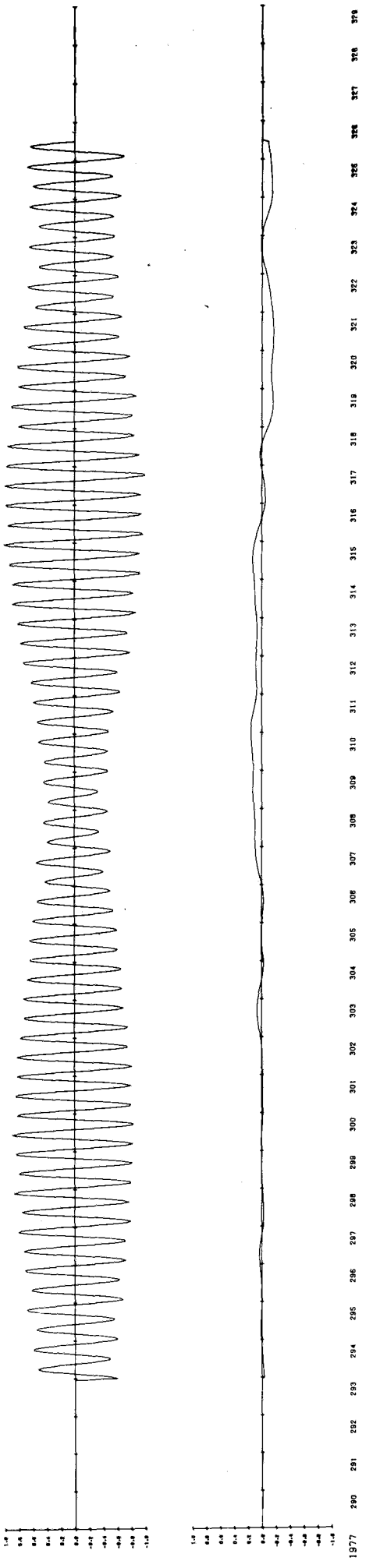
Constituent	related to	days 152 to 180 H(m)	G(°)	182 to 210 H(m)	G(°)	Vector mean H(m)	G(°)
Q1		0.041	308.3	0.052	322.2	0.046	316.2
O1		0.096	29.3	0.100	42.9	0.097	36.3
M1		0.018	154.5	0.033	167.1	0.026	162.7
* π1	K1	0.005	74.5	0.005	68.6	0.005	71.5
* P1	K1	0.043	173.0	0.046	167.1	0.044	170.0
K1		0.118	179.7	0.127	173.8	0.122	176.7
* ψ1	K1	0.010	85.7	0.010	79.8	0.010	82.7
* Ø1	K1	0.009	186.7	0.009	180.8	0.009	183.7
J1		0.008	11.9	0.007	355.1	0.008	4.1
OO1		0.003	264.3	0.016	325.1	0.009	316.4
* 2N2	N2	0.102	259.7	0.101	258.9	0.102	259.4
μ2		0.030	76.4	0.027	87.9	0.028	81.9
N2		0.565	293.0	0.560	292.2	0.563	292.7
* ν2	N2	0.120	291.6	0.119	290.8	0.120	291.3
M2		2.967	315.9	2.962	316.5	2.965	316.2
L		0.159	341.1	0.122	351.5	0.140	345.7
* T2	S2	0.058	357.2	0.056	356.3	0.057	356.8
S2		0.980	358.4	0.952	357.5	0.966	358.0
* K2	S2	0.287	356.7	0.279	355.8	0.283	356.3
2SM2		0.014	213.9	0.023	229.9	0.018	223.9
MO3		0.003	156.9	0.007	259.6	0.003	235.8
M3		0.037	289.7	0.034	285.7	0.035	287.8
MK3		0.020	352.3	0.026	11.9	0.022	3.5
MN4		0.076	160.5	0.069	153.9	0.072	157.4
M4		0.168	195.2	0.169	198.9	0.168	197.1
SN4		0.013	8.5	0.021	295.0	0.014	321.8
MS4		0.079	238.2	0.082	248.0	0.080	243.3
2MN6		0.023	340.1	0.021	338.6	0.022	339.4
M6		0.032	14.7	0.032	21.0	0.032	17.9
MSN6		0.002	290.0	0.008	82.5	0.003	73.6
2MS6		0.023	60.0	0.025	69.1	0.024	64.9
2SM6		0.004	95.9	0.006	94.0	0.005	94.8

OSTG position	Station D, Eastern Irish Sea, 1977. Lat 53°45.8'N, Long 04°07'W. $g = 9.814\ ms^{-2}$.
Water depth	48m (PDR). 42m (chart).
OSTG details	a) Aanderaa OSTG type 2A/64. 900s sampling and 104s integration periods. b) Aanderaa TG/SG 280 incorporating SG 2/10 sensor. 900s sampling and integration periods. See Comments
Time of launch	OSTG in water from MV "Prince Madog" at 1819 GMT day 290 (17 October), and on sea bed at 1821 GMT.
Time of recovery	Recovery started from MV "Prince Madog" at 1555 GMT day 329 (25 November), and completed at 1700 GMT.
CTD casts	None. Estimated density, $\rho = 1026.881\ Kgm^{-3}$.
Comments	Current meters 567/8, 2575/3, and 1139/8 at 22m, 16m, and 8m above sea bed respectively were deployed on the same rig. On recovery, acoustic release fired but instrument frame did not float to surface. Therefore rig was retrieved by winching in pillar buoy and ground line.

Timing	a) Scan no. 305 at 1859,58 GMT day 290 (17 October) Scan no. 4036 at 1544,55 GMT day 329 (25 November) Clock fast, gained 3s in 38 days and 20¾ hours. b) Scan no. 1 at 1445,00s GMT day 287 (14 October) No times taken on recovery, therefore no corrections made for clock errors.
Raw data	a) Start 1914,08 GMT day 290. End 1544,05 GMT day 329. b) Start 1852,30 GMT day 290. End 2107,30 GMT day 321. See Comments.
Temperature data	No temperature sensor on Aanderaa 2A/64. Data from Aanderaa TG/SG temperature sensor, start and end times as for b) above.
Drift free data	a) Start 0000 GMT day 294. End 1100 GMT day 326. FHP53 filter used. b) Start 2300 GMT day 293. End 1600 GMT day 318. FHP53 filter used.
Tidal Analaysis	a)i) TIRA, 0000 GMT day 294 to 2300 GMT day 322, 29 days of filtered data, using 27 major and 8 related constituents from Hilbre Island analysis (1964/65). ii) TIRA, 0000 GMT day 294 to 2300 GMT day 308, 15 days of filtered data using 22 major and 17 related constituents from Hilbre Island analysis (1964/65). b) TIRA, using data and constituents as foraii).
Comments	Discontinuities in all records at 0345 GMT day 311, due to rig movements, were smoothed manually. Discontinuities in Aanderaa TG/SG pressure and temperature records starting at 0530 GMT day 312, due to voltage supply malfunction were smoothed manually. Truncation of records at 2107,30 GMT day 321 due to voltage supply failure.

AANDERAA TG/SD 280 OCT/NOV 1977
IRISH SEA STATION 'O' 53 45.8N 04 07W

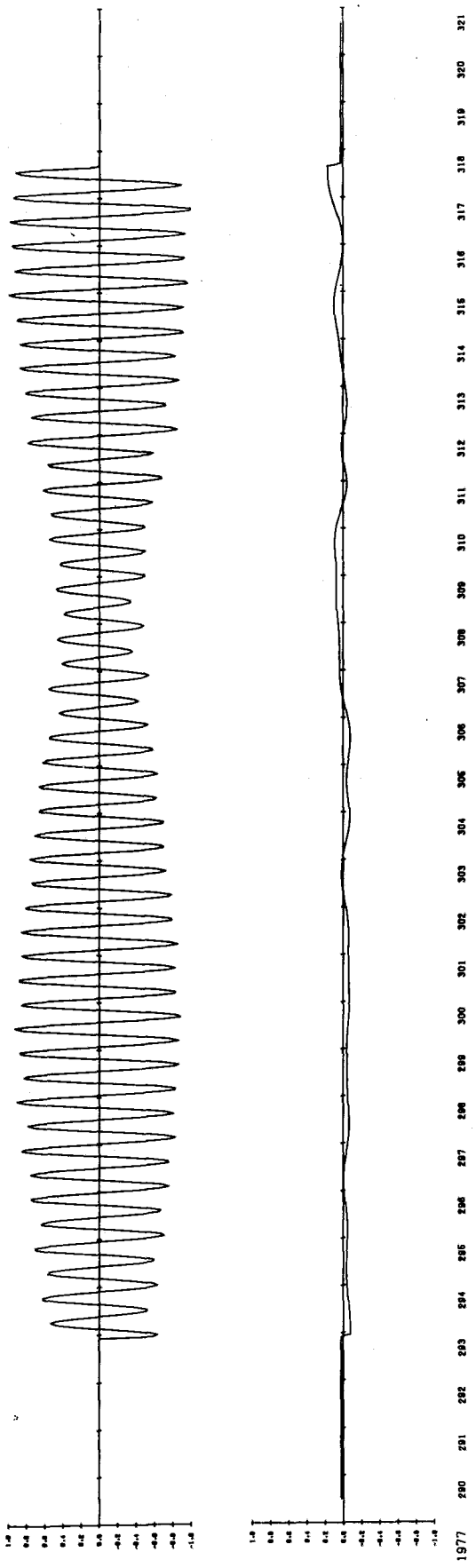




FILTERED VALUES
SCALE Y=0.36617 E03
MEAN VALUE=0.53674 E04

RESIDUALS
SCALE Y=0.36617 E03
MEAN VALUE=0.53670 E04

PRISM SEA STATION 3 2m.S4 TOTAL PRESSURE



FILTERED VALUES
SCALE Y=0.34657 E03
MEAN VALUE=0.53723 E04

RESIDUALS
SCALE Y=0.34657 E03
MEAN VALUE=0.53634 E04

IRISH SEA STATION D TG/SG TOTAL PRESSURE

Station D, Eastern Irish Sea, 1977. Lat 53°45.8'N, Long 04°07'W.
Aanderaa OSTG 2A/64 and Aanderaa OSTG TG/SG 280.
29 days filtered and 15 days filtered total pressure data (millibars).
*Related constituents from Hilbre Island analysis (1964/65).

Constituent	rltd. to	15 days 294 to 308, 1977 OSTG TG/SG H(mb)	G(°)	OSTG 2A/64 H(mb)	G(°)	29 days 294 to 322, 1977 Constituent	rltd. to	OSTG 2A/64 H(mb)	G(°)
2Q1		4.0	302.2	3.8	301.6				
* σ1	2Q1	2.9	178.0	2.8	177.3				
* Q1	O1	4.1	13.0	3.9	8.8	Q1		4.7	36.3
* ρ1	O1	1.0	345.5	1.0	341.3				
O1		11.2	45.2	10.6	41.0	O1		10.7	46.4
* π1	K1	0.3	91.4	0.4	94.6	M1		1.0	191.1
* P1	K1	2.9	189.9	3.1	193.1	π1*	K1	0.4	95.8
* S1	K1	1.1	142.6	1.2	145.8	P1*	K1	3.4	194.3
K1		7.9	196.6	8.3	199.8	K1		9.5	201.0
* ψ1	K1	0.6	102.6	0.7	105.8	ψ1*	K1	0.8	107.0
* Ø1	K1	0.6	203.6	0.6	206.8	Ø1*	K1	0.7	208.0
* J1	OO1	2.9	263.1	3.3	260.9	J1		0.9	295.8
OO1		4.8	76.6	5.4	74.4	OO1		3.1	84.7
*MNS2	2N2	0.9	100.2	0.9	100.3				
2N2		7.8	289.8	8.0	289.9	2N2*	N2	8.1	260.9
* μ2	2N2	2.4	75.2	2.4	75.3	μ2		1.2	274.4
* N2	M2	45.9	293.0	46.0	292.9	N2		44.5	294.2
* ν2	M2	9.8	291.6	9.8	291.5	ν2*	N2	9.5	292.8
M2		238.1	316.2	238.6	316.1	M2		237.4	317.2
* L2	M2	10.8	330.1	10.8	330.0	L2		9.6	311.0
* T2	S2	4.4	354.0	4.4	353.9	T2*	S2	4.4	354.8
S2		74.9	355.2	75.0	355.1	S2		74.5	356.0
* K2	S2	22.0	353.5	22.0	353.4	K2*	S2	21.8	354.3
*MSN2	2SM2	1.5	180.5	1.7	193.2	2SM2		2.4	219.2
2SM2		1.9	180.9	2.2	193.6				
MO3		0.6	352.9	1.1	1.8	MO3		0.4	3.9
M3		2.1	262.8	1.6	256.7	M3		2.0	274.6
MK3		0.3	337.4	0.6	291.2	MK3		0.3	356.7
MN4		3.8	213.6	3.4	223.2	MN4		2.8	185.9
M4		9.7	208.4	9.2	215.0	M4		6.3	200.9
SN4		3.0	260.9	2.6	288.2	SN4		1.1	136.1
MS4		5.9	240.2	5.7	246.5	MS4		3.7	235.3
2MN6		0.4	68.3	0.9	80.7	2MN6		0.2	333.2
M6		1.6	39.8	1.9	43.9	M6		0.6	354.0
MSN6		0.9	96.5	1.3	109.6	MSN6		0.3	306.4
2MS6		1.2	55.8	1.3	57.5	2MS6		0.6	27.0
2SM6		0.2	67.1	0.2	14.7	2SM6		0.3	15.9

9. CURRENT RECORD FORMAT

The report is split into sections, one for each mooring, each section beginning with a page of mooring details showing:-

Mooring number : IOS Bidston reference number.

Position of rig : Station identification letter, Latitude and longitude.

Depth of water : from the pressure sensor fitted to the top meter on the rig.

Tidal heights : from the tidal predictions for the nearest port giving the heights above chart datum of the

mean high water springs	MHWS
mean high water neaps	MHWN
mean low water springs	MLWS
mean low water neaps	MLWN

Meter information : the meter number, the type of meter, the height of the meter's rotor above the anchor.

Time of set : the time that the surface buoy was released from the ship.

Time of recovery : the time that the surface buoy was brought on board the ship.

Mooring : any additional information on the mooring.

Another page of information is included before the results from each meter. This contains:-

Meter information : manufacturer and meter identification number.

Tape number	:	identification of the record.
Times	:	the times when the meter was started and stopped together with the calculated timing error and the total number of readings.
Length of useful record	:	times of start and end of velocity time series, total length of useful data.
Comments	:	comments on the meter, its behaviour and the quality of the record.

The results are displayed in five graphs produced on a Computer Instrumentation Limited 6011 plotter linked to the Institute's IBM 1130 computer. The diagrams are:-

(1) A plot of the temperature, pressure (if appropriate) and the North and East components of velocity against time. The whole data series obtained (10 minute values in this case) is used as the input for this graph. The lines on the time axis indicate midnight (0000 GMT).

(2) Histograms of speed and direction. Plots of the percentage of the data which lie within a certain interval of speed or direction. The direction histogram is split into intervals of 18^{o}, the speed range is flexible depending on the maximum speed recorded.

(3) A scatter diagram of the North component of velocity against the East component. The scale is in cm s^{-1}, each dot representing a reading of the meter. The eccentricity of the tidal ellipse is clearly indicated, showing the contrast between the almost rectilinear tidal stream in the upper layer and the noticeably

elliptical motion nearer the bed. This diagram is particularly useful in revealing malfunctions in the meter's compass or in the rig itself.

(4) Two progressive vector diagrams. One uses the same data as diagram 1; the other uses the data filtered by applying a running average over a period of 24 hrs 50 mins (two tidal cycles) to remove most of the tidal signal and hence show the residual movement more clearly. For any record, the scale (in kms) and orientation are the same for both graphs. A drift of 1 km d^{-1} is equivalent to a residual speed of 1.16 cm s^{-1}. The crosses mark midday (1200 GMT) each day. Care is needed in interpreting these graphs, they indicate the time variation of the current vector at the meter and not the path of a particle.

Mooring number : 119

Position of rig : LAT. 53° 28.9'N. LONG. 3° 29.2'W (RIG 3)

Depth of water : 21m below chart datum

Tidal heights, in metres above chart datum, at Hilbre Island : MHWS 8.6, MHWN 6.7, MLWN 2.5, MLWS 0.8

Meter	Type	Height above sea floor (m)	Recording interval (min)
2576	Aanderaa RCM 4	8	10

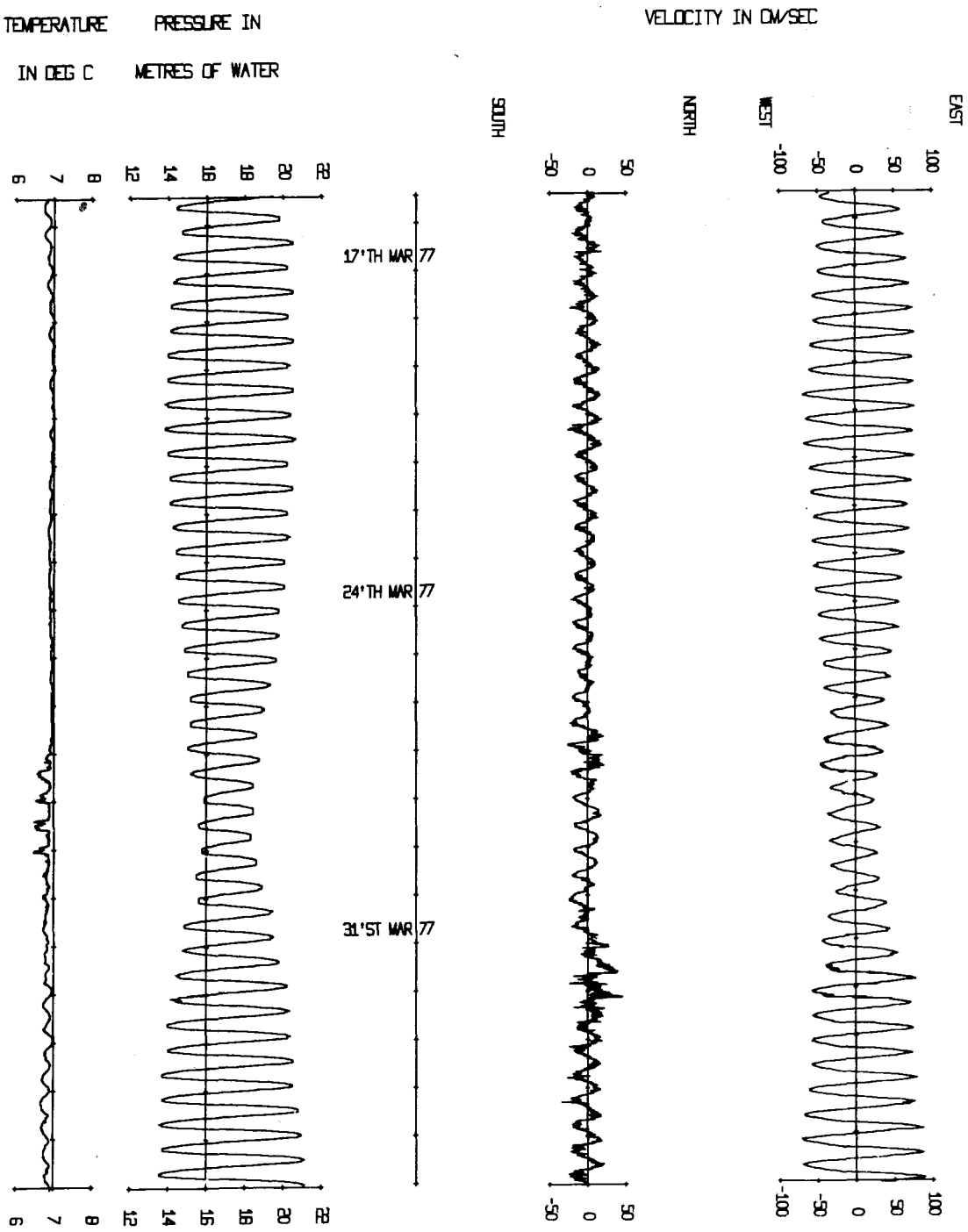
Rig set : 09.55 GMT 16 March 1977 from RRS 'John Murray'.

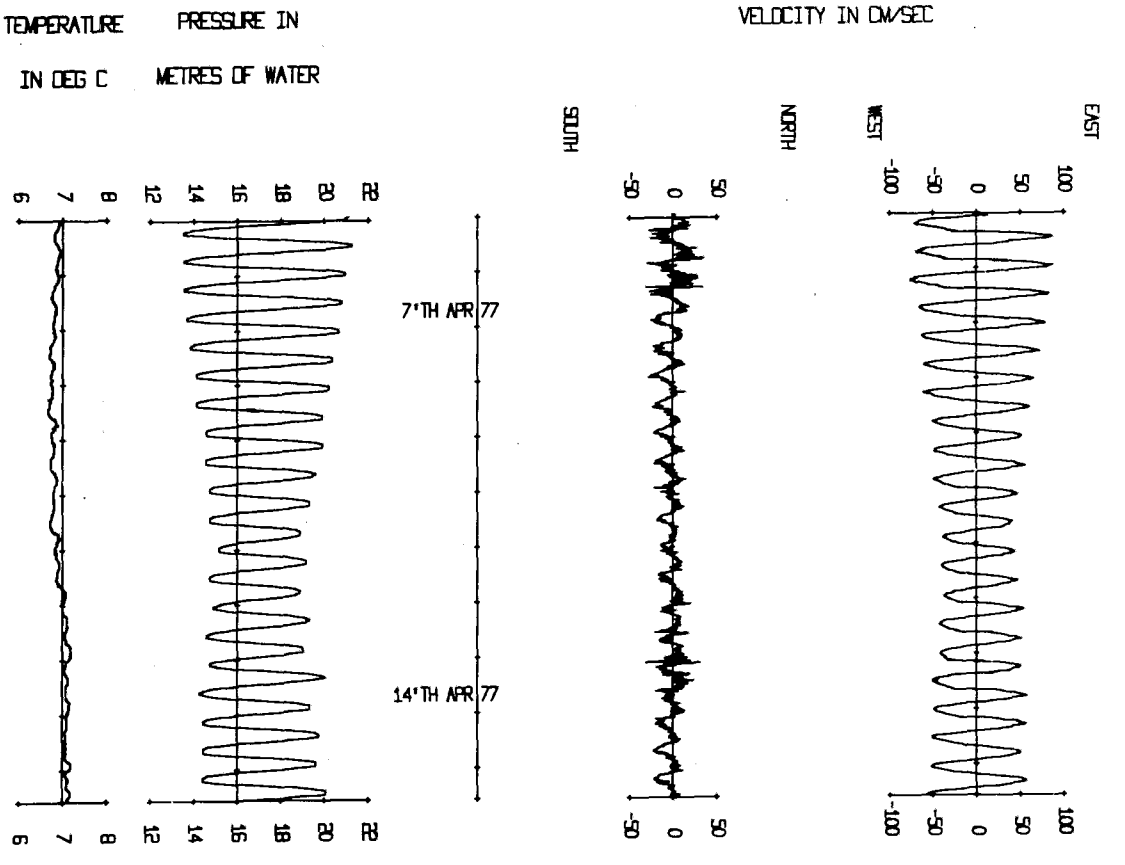
Rig recovered : 13.53 GMT 16 April 1977 from RRS 'John Murray'

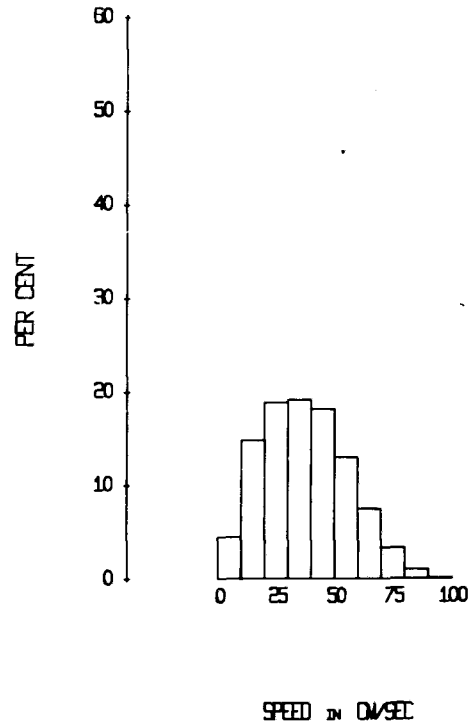
Mooring : Standard

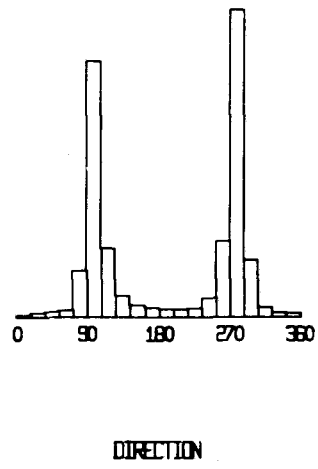
Comments : The launch and recovery were successfully accomplished at the first attempt.

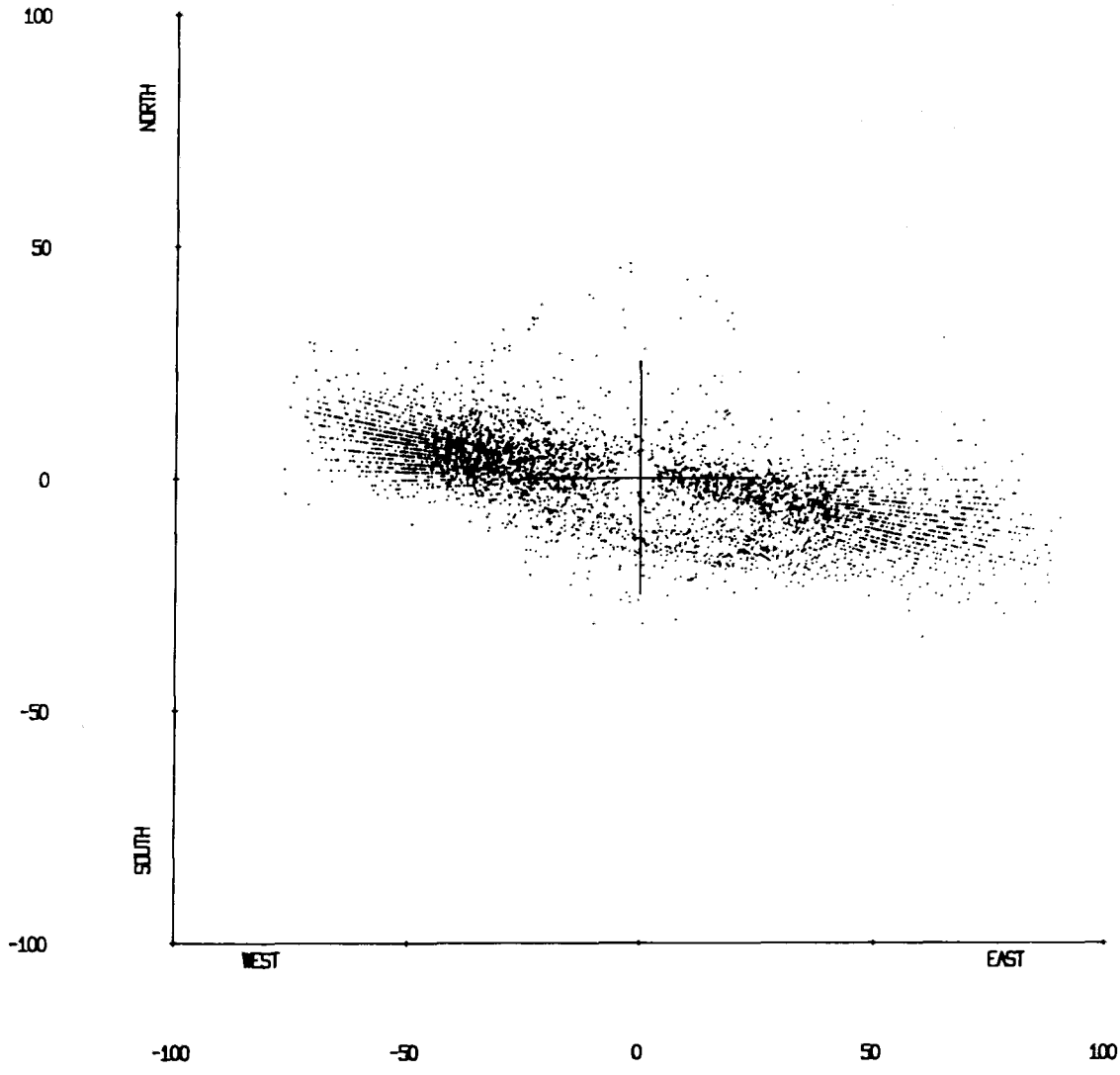
Meter	:	Aanderaa 2576
Tape number	:	2576/1
Meter started	:	08.08.53 GMT 16 March 1977
Meter stopped	:	14.49.20 GMT 16 April 1977
Total number of readings	:	4505
Timing error	:	27s slow
Start of useful record	:	09.59 GMT 16 March 1977
End of useful record	:	13.29 GMT 16 April 1977
Length of useful record	:	747 h
Comments	:	Good record. The meter was fitted with a 0-200 PSI pressure sensor and a new Aanderaa spindle. It was recovered in good condition. There were very few errors in the record.

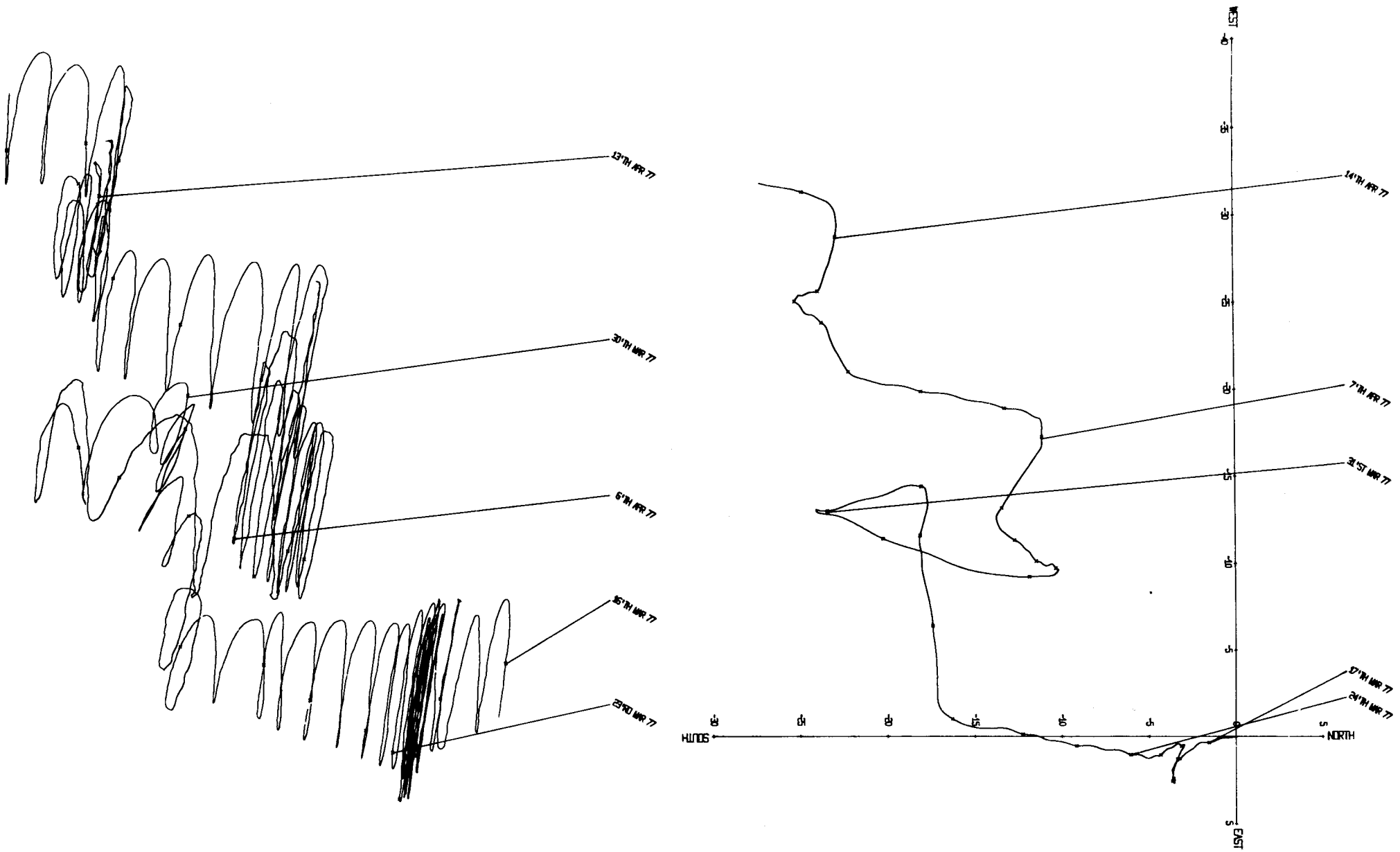

TEMPERATURE
IN DEG C
PRESSURE IN
METRES OF WATER
VELOCITY IN CM/SEC
SOUTH
NORTH
WEST
EAST
17'TH MAR 77
24'TH MAR 77
31'ST MAR 77


TEMPERATURE
IN DEG C
PRESSURE IN
METRES OF WATER
VELOCITY IN CM/SEC
6
7
8
12
14
15
16
20
22
7'TH APR 77
14'TH APR 77
SOUTH
NORTH
WEST
EAST
-50
0
50
-100
100


PER CENT
60
50
40
30
20
10
0
0
25
50
75
100
SPEED IN CM/SEC


0
90
180
270
360
DIRECTION


100
50
0
-50
-100
NORTH
SOUTH
WEST
EAST
-100
-50
0
50
100


13TH APR 77
30TH MAR 77
6TH APR 77
16TH MAR 77
23RD MAR 77
14TH APR 77
7TH APR 77
31ST MAR 77
17TH MAR 77
24TH MAR 77
WEST
EAST
SOUTH
NORTH

Mooring number : 120

Position of rig : LAT. 53° 46.2'N LONG. 3° 17.8'W (RIG 9)

Depth of water : 15m below chart datum

Tidal heights, in metres above chart datum, at Hilbre Island : MHWS 8.6 MHWN 6.7 MLWN 2.5 MLWS 0.8

Meter	Type	Height above sea floor (m)	Recording interval (min)
1867	Aanderaa RCM 4	6	10

Rig set : 14.06 GMT 16 March 1977 from R.R.S. 'John Murray'

Rig recovered : 07.20 GMT 19 April 1977 from R.R.S. 'John Murray'

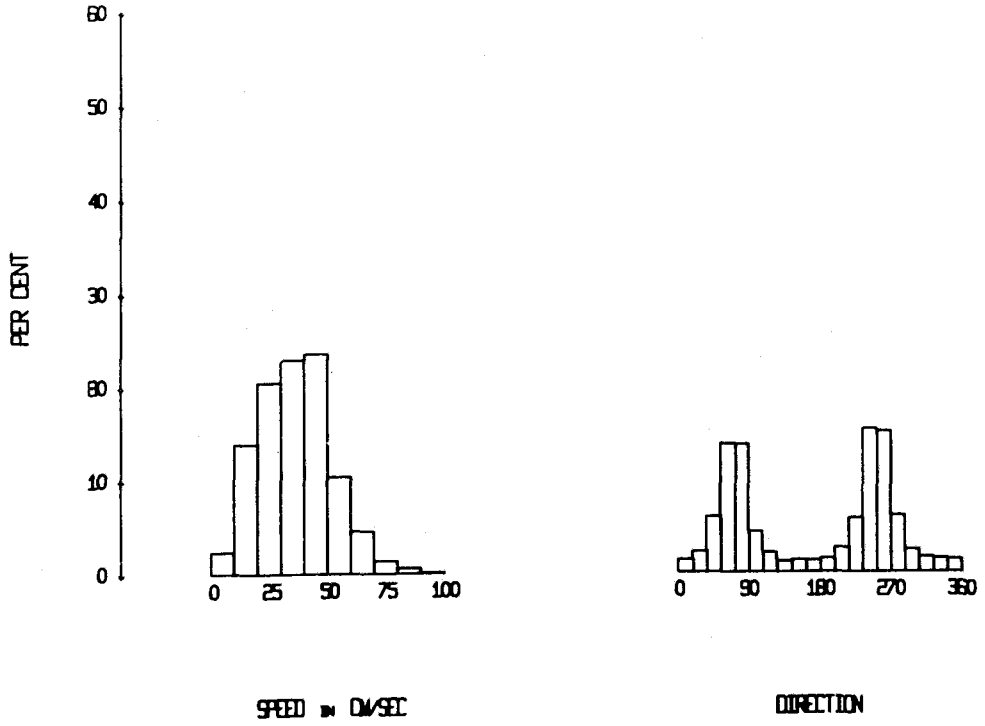
Mooring : Standard

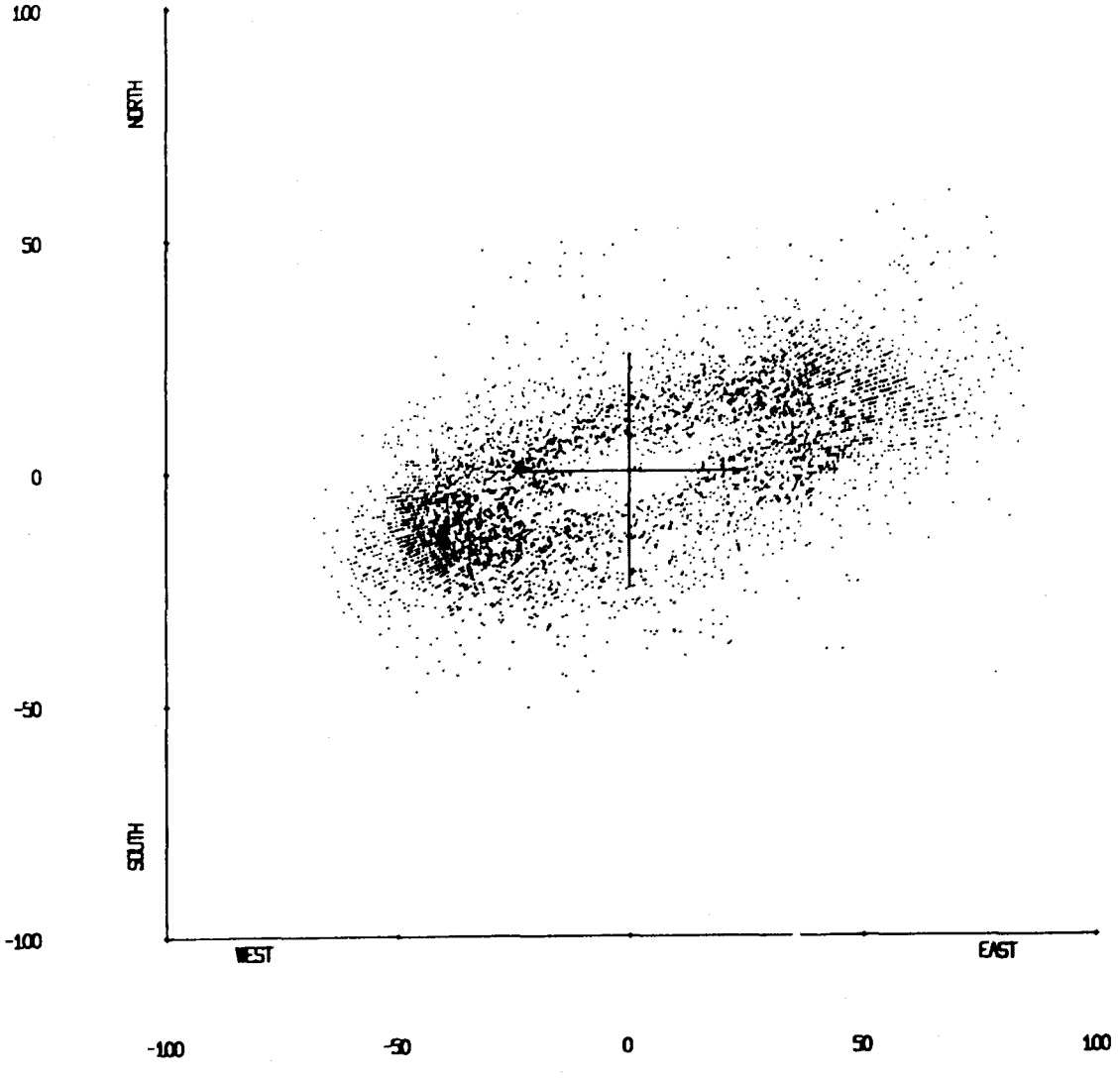
Comments : The launch was successfully accomplished at the first attempt. The surface buoy drifted ashore at Blackpool during March. On 16 April an unsuccessful drag and acoustic search was executed for several hours. A second attempt at dragging, on 19 April, was rewarded at the third pass when the grapnel caught in the meter wire below the acoustic pinger. During the recovery the fin was damaged. There were cable marks on the sub-surface buoy and acoustic pinger which had been made before the recovery. The rig does not appear to have moved.

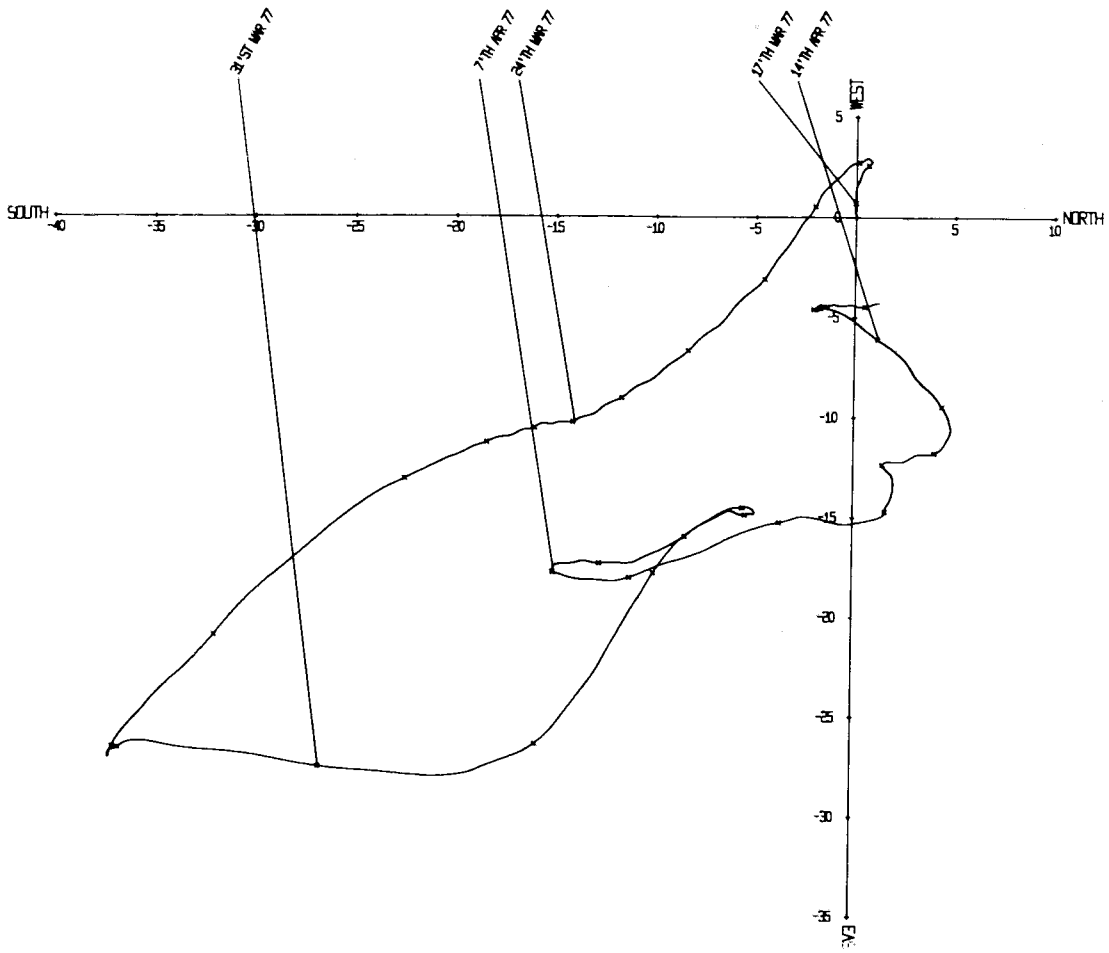
Meter	:	Aanderaa 1867
Tape number	:	1867/3
Meter started	:	12.58.53 GMT 16 March 1977
Meter stopped	:	08.28.31 GMT 19 April 1977
Total number of readings	:	4870
Timing error	:	22s fast
Start of useful record	:	14.09 GMT 16 March 1977
End of useful record	:	06.39 GMT 19 April 1977
Length of useful record	:	808 h
Comments	:	Good record. The meter was fitted with a 0-200 PSI pressure sensor and a new Aanderaa spindle. Faulty velocity data for 2 hours on 10 April.

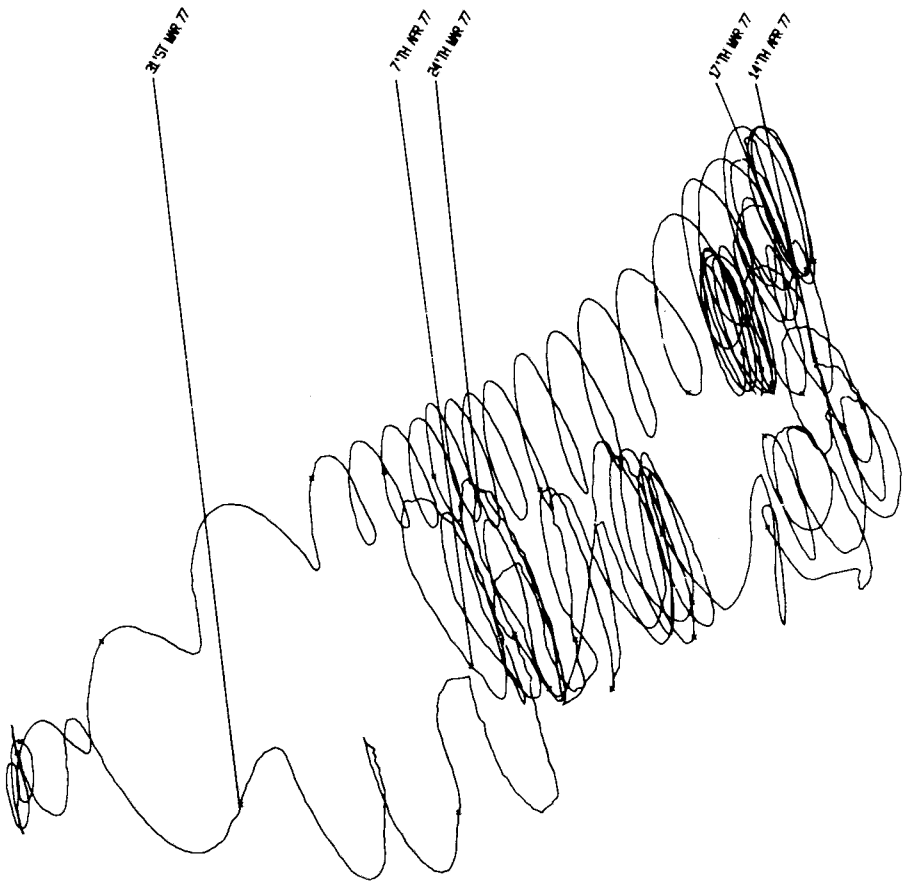
TEMPERATURE
IN DEG C
PRESSURE IN
METRES OF WATER
VELOCITY IN CM/SEC
SOUTH
NORTH
WEST
EAST
17'TH MAR 77
24'TH MAR 77
31'ST MAR 77

TEMPERATURE
IN DEG C
PRESSURE IN
METRES OF WATER
VELOCITY IN CM/SEC
7'TH APR 77
14'TH APR 77
SOUTH
NORTH
WEST
EAST
-100
-50
0
50
100
5
6
7
8
10
12
14
15
16
18
20


PER CENT
60
50
40
30
20
10
0
0
25
50
75
100
SPEED IN CM/SEC
0
90
180
270
360
DIRECTION


100
50
0
-50
-100
NORTH
SOUTH
WEST
EAST
-100
-50
0
50
100


31ST MAR 77
7TH APR 77
24TH MAR 77
17TH MAR 77
14TH APR 77
WEST
SOUTH
NORTH
EAST
-40
-35
-30
-25
-20
-15
-10
-5
0
5
10
-5
-10
-15
-20
-25
-30
-35


31ST MAR 77
7TH APR 77
24TH MAR 77
17TH MAR 77
14TH APR 77

Mooring number : 121

Position of rig : LAT. 53° 41.3'N LONG 3° 32.3'W (RIG 6)

Depth of water : 38m below chart datum

Tidal heights, in metres above chart datum, at Hilbre Island :	MHWS	MHWN	MLWN	MLWS
	8.6	6.7	2.5	0.8

Meter	Type	Height above sea floor (m)	Recording interval (min)
236	Aanderaa RCM4	18	10
406	Aanderaa RCM4	8	10

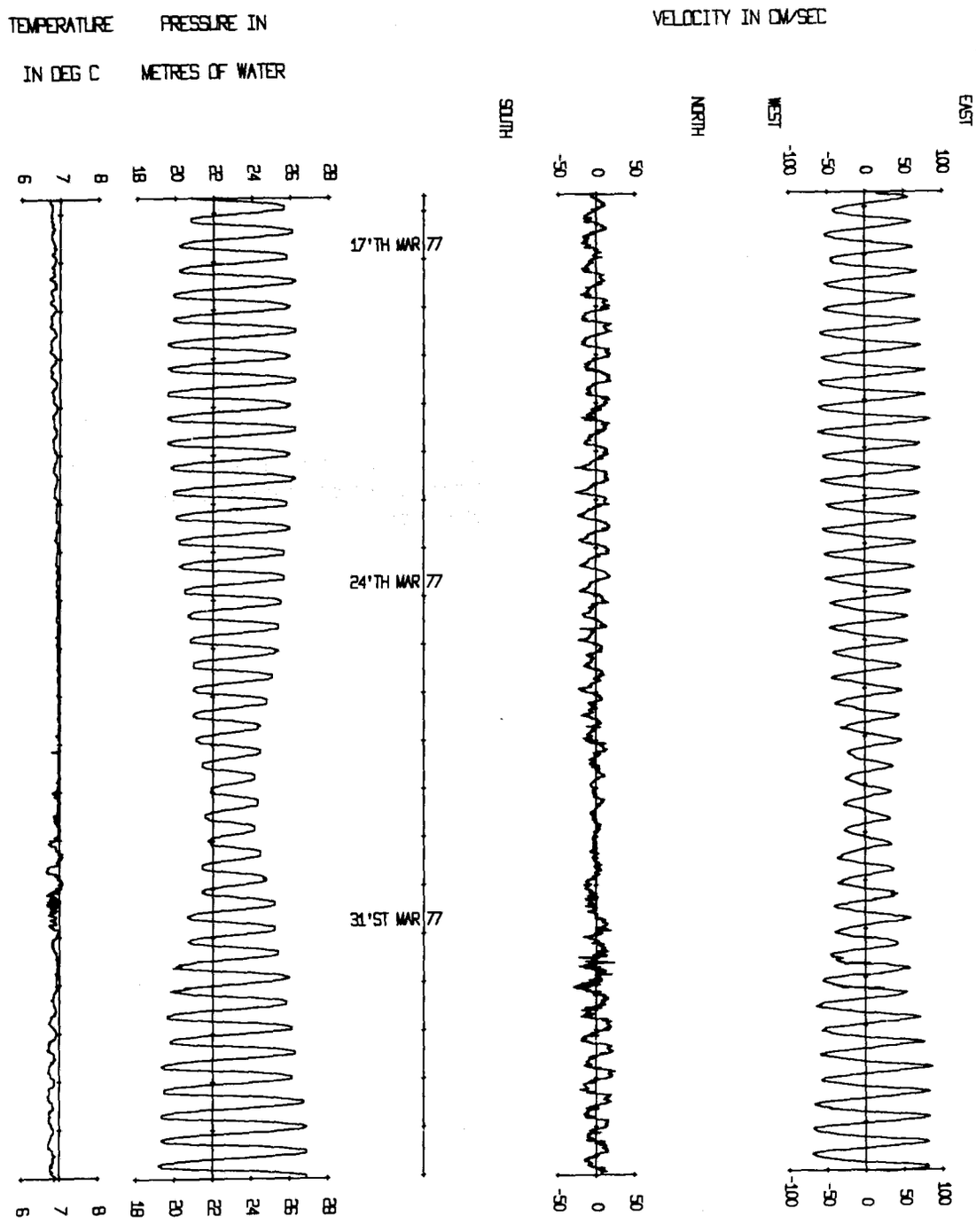
Rig set : 16.12 GMT 16 March 1977 from R.R.S. 'John Murray'

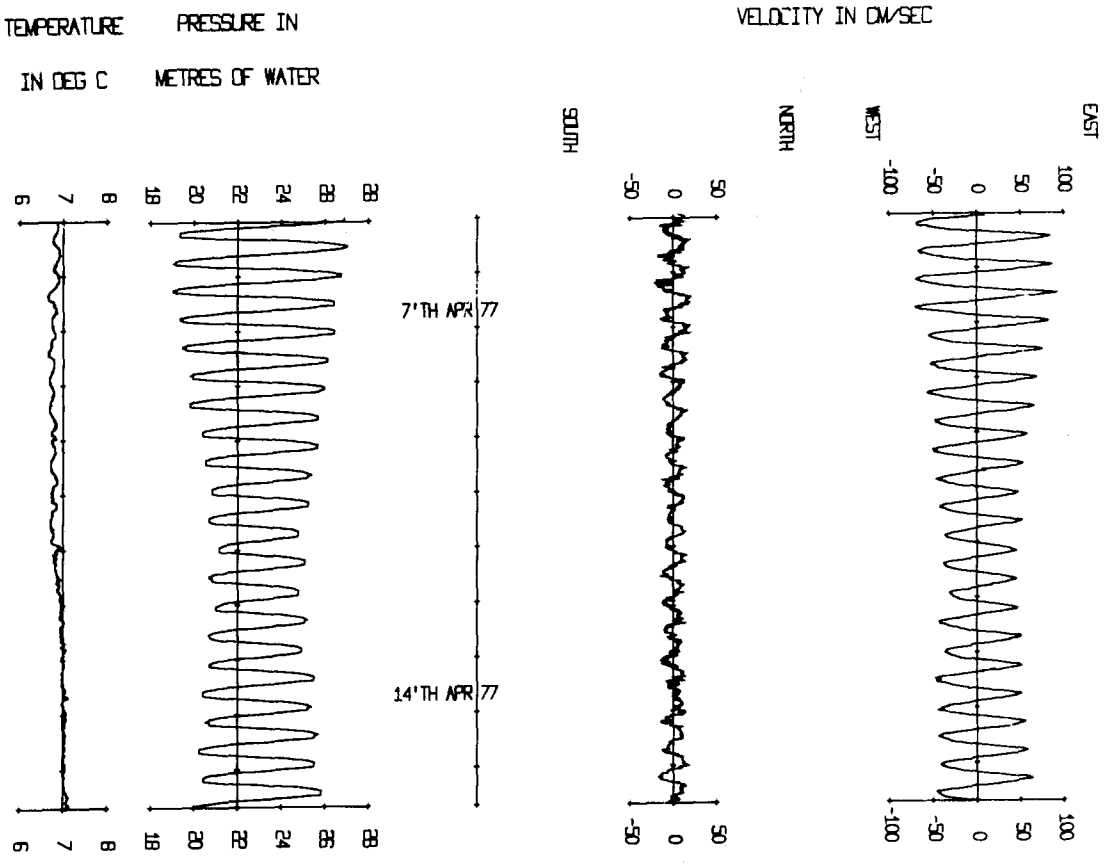
Rig recovered : 16.53 GMT 16 April 1977 from R.R.S. 'John Murray'.

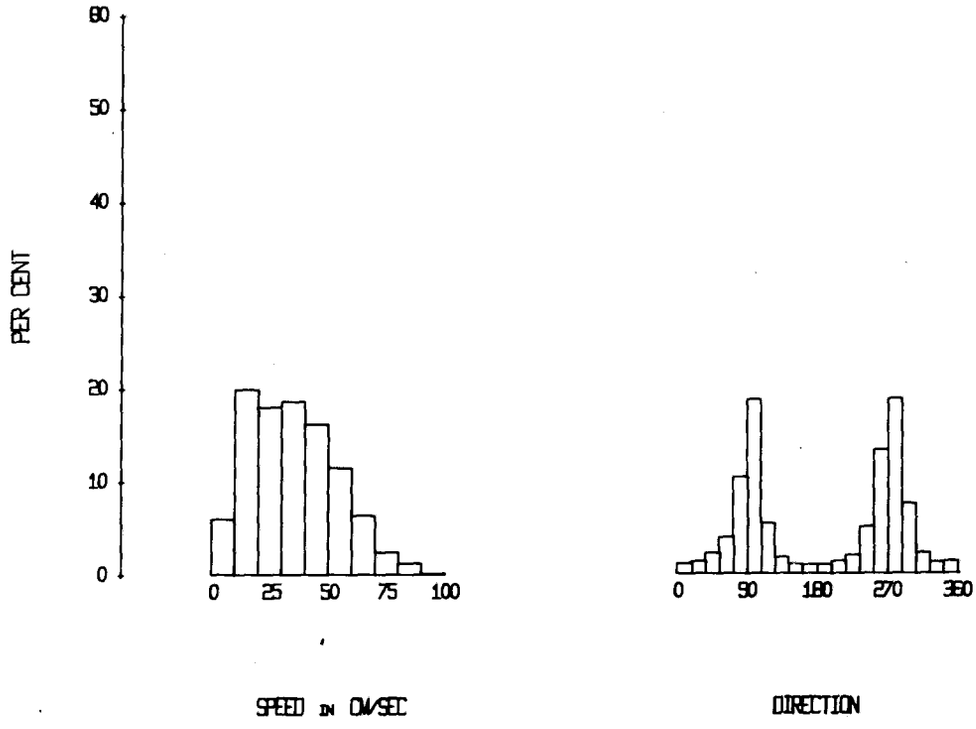
Mooring : Standard

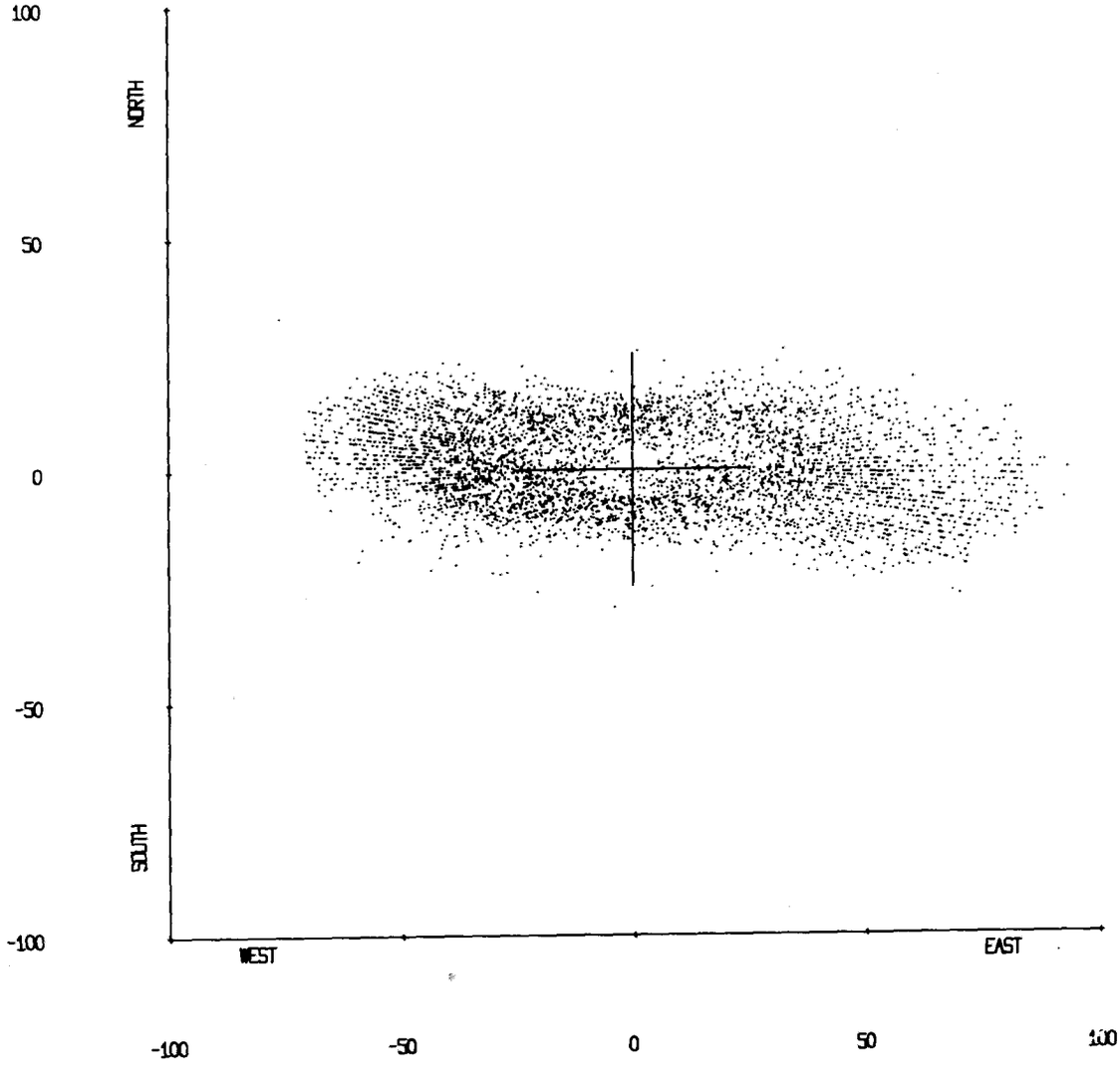
Comments : The launch and recovery were successfully accomplished at the first attempt. The surface buoy anchor was missing on recovery and the strop may have broken during recovery. The rig had not moved.

Meter	:	Aanderaa 236
Tape number	:	236/10
Meter started	:	14.58.53 GMT 16 March 1977
Meter stopped	:	17.58.54 GMT 16 April 1977
Total number of readings	:	4483
Timing error	:	1s slow
Start of useful record	:	16.29 GMT 16 March 1977
End of useful record	:	16.39 GMT 16 April 1977
Length of useful record	:	744 h
Comments	:	Good record. The meter was fitted with a 0-200 PSI pressure sensor and an Aanderaa spindle. The meter was recovered in good condition. There were very few errors in the record.


TEMPERATURE
IN DEG C
PRESSURE IN
METRES OF WATER
VELOCITY IN CM/SEC
SOUTH
NORTH
WEST
EAST
17'TH MAR 77
24'TH MAR 77
31'ST MAR 77
6
7
8
16
20
22
24
26
28
-50
0
50
-100
-50
0
50
100


TEMPERATURE
IN DEG C
PRESSURE IN
METRES OF WATER
VELOCITY IN CM/SEC
6
7
8
18
20
22
24
26
28
7'TH APR 77
14'TH APR 77
SOUTH
NORTH
WEST
EAST
-50
0
50
-100
100


PER CENT
60
50
40
30
20
10
0
0
25
50
75
100
SPEED IN CM/SEC
0
90
180
270
360
DIRECTION

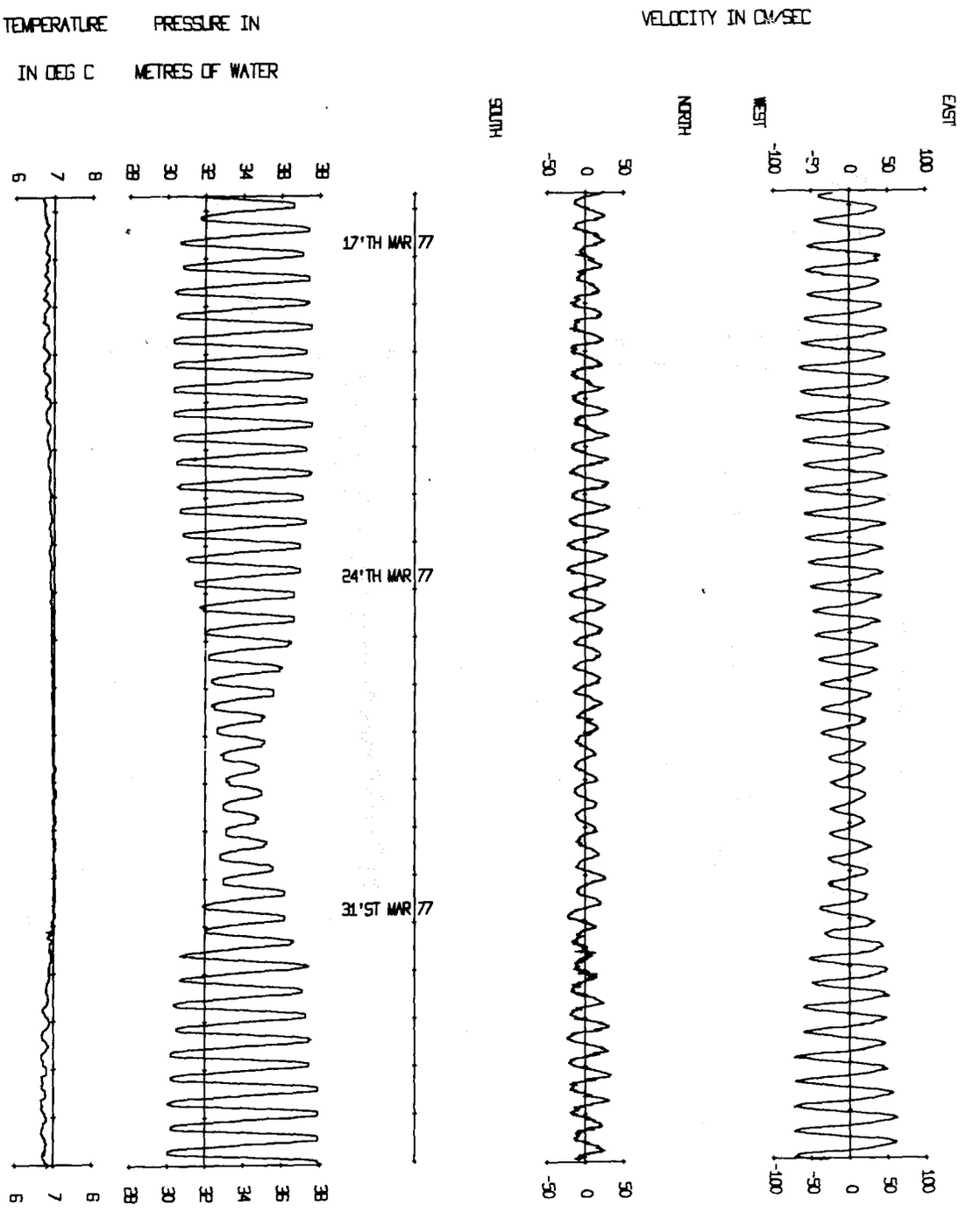

100
50
0
-50
-100
NORTH
SOUTH
WEST
EAST
-100
-50
0
50
100

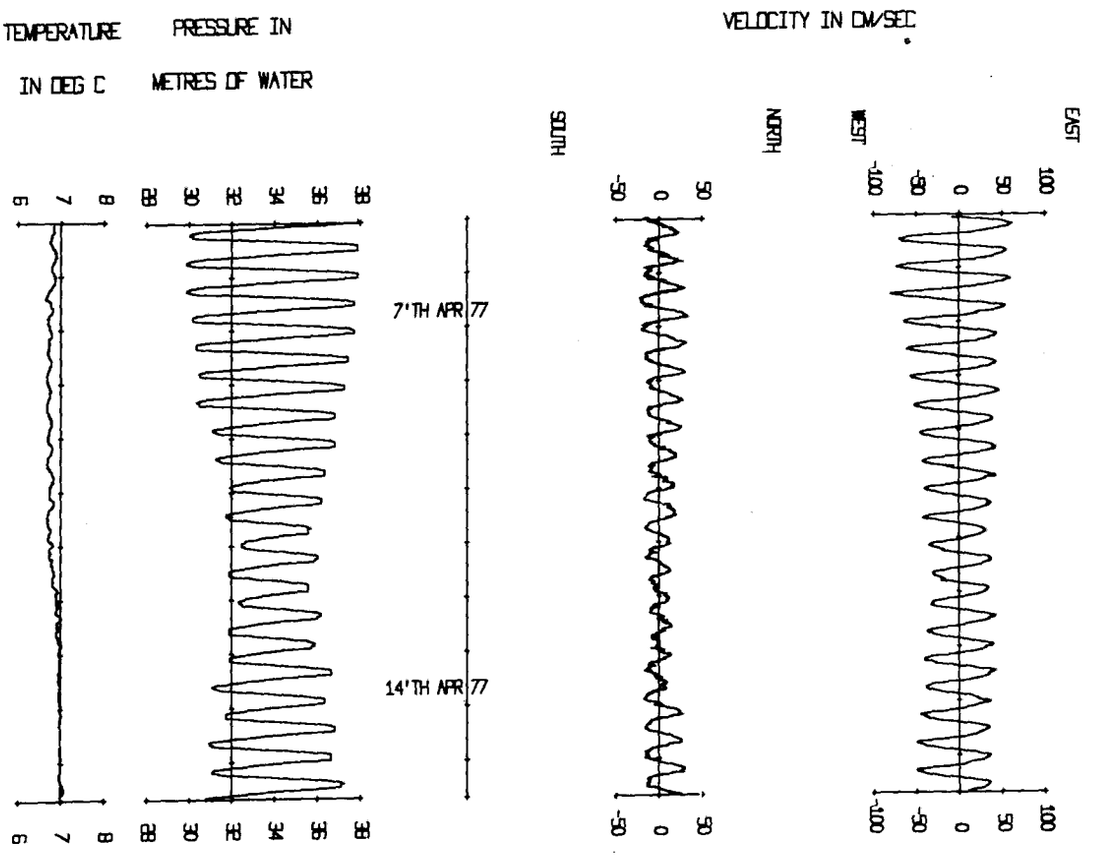
WEST
EAST
SOUTH
NORTH
17'TH MAR 77
14'TH APR 77
24'TH MAR 77
31'ST MAR 77

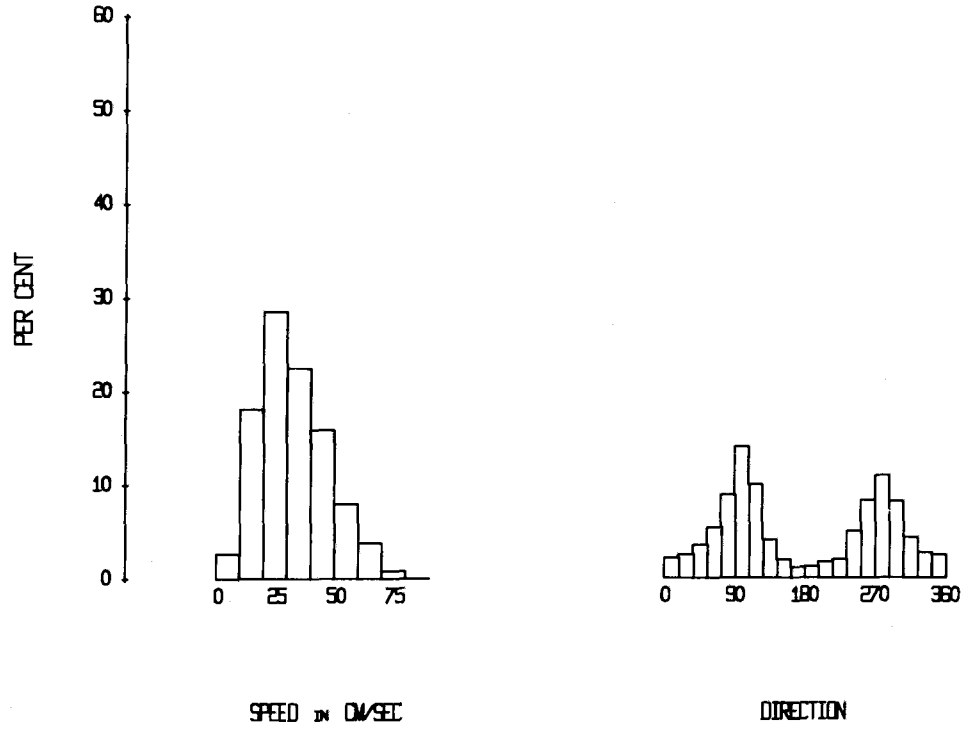
17'TH MAR 77
14'TH APR 77
7'TH APR 77
24'TH MAR 77
31'ST MAR 77

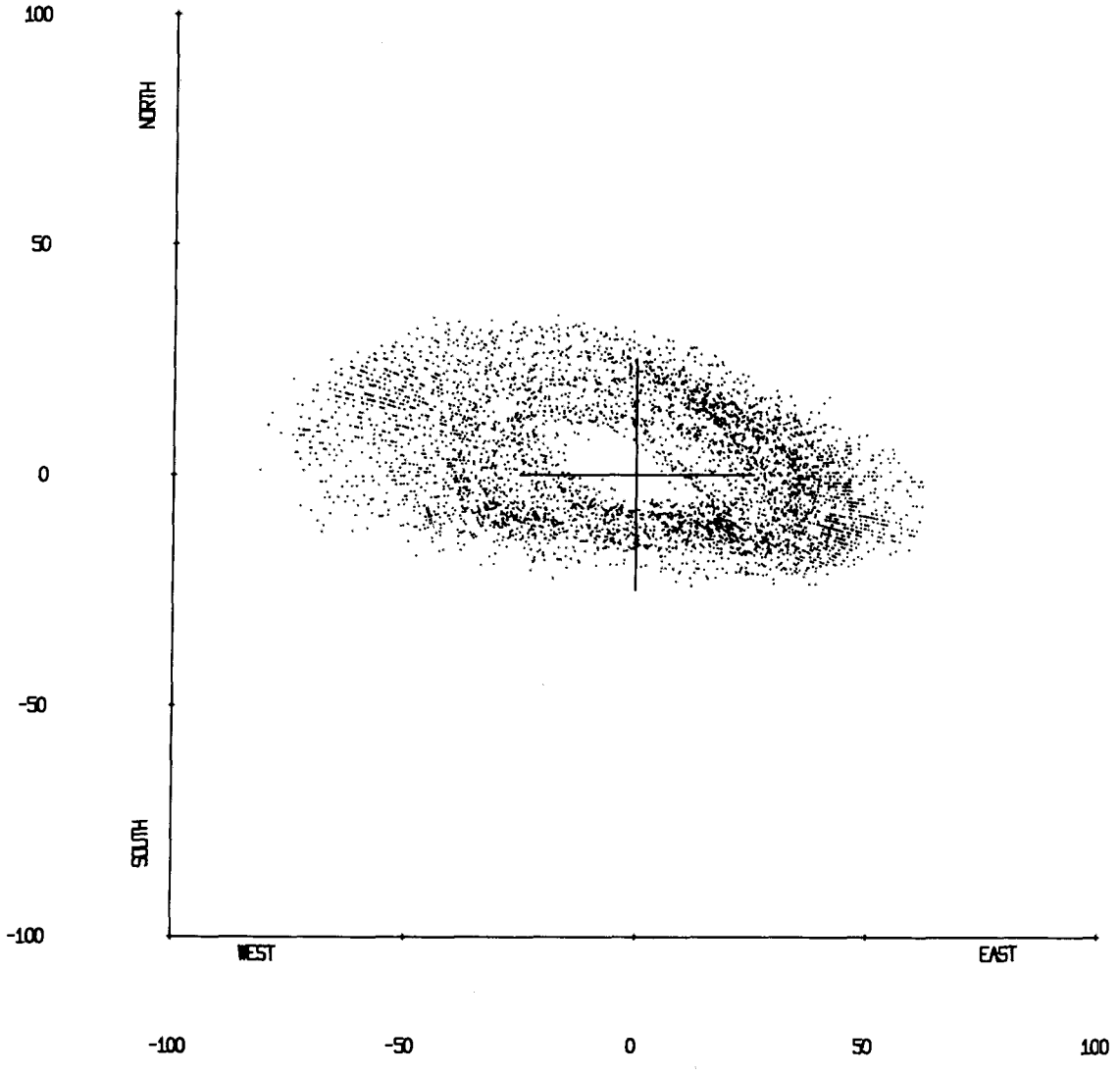
Meter	:	Aanderaa 406
Tape number	:	406/10
Meter started	:	14.48.53 GMT. 16 March 1977
Meter stopped	:	18.09.30 GMT. 16 April 1977
Total number of readings	:	4485
Timing error	:	37 s slow
Start of useful record	:	16.29 GMT. 16 March 1977
End of useful record	:	16.40 GMT. 16 April 1977
Length of useful record	:	744 h
Comments	:	Good record. The meter was fitted with a 0-200 PSI pressure sensor and an Aanderaa spindle. It was recovered in good condition, but the spindle was slightly stiff.

NOTE: All directions are in error by 180°.


TEMPERATURE
IN DEG C
PRESSURE IN
METRES OF WATER
VELOCITY IN CM/SEC
SOUTH
NORTH
WEST
EAST
17'TH MAR 77
24'TH MAR 77
31'ST MAR 77


TEMPERATURE
IN DEG C
PRESSURE IN
METRES OF WATER
VELOCITY IN CM/SEC
6
7
8
28
30
32
34
36
38
7'TH APR 77
14'TH APR 77
SOUTH
NORTH
WEST
EAST
-50
0
50
-100
100


PER CENT
60
50
40
30
20
10
0
0
25
50
75
0
90
180
270
360
SPEED IN CM/SEC
DIRECTION


100
50
0
-50
-100
NORTH
SOUTH
WEST
EAST
-100
-50
0
50
100

17TH MAR 77
24TH MAR 77
31ST MAR 77
7TH APR 77
14TH APR 77

SOUTH
EAST
WEST
NORTH
17TH MAR 77
24TH MAR 77
31ST MAR 77
7TH APR 77
14TH APR 77

Mooring number : 122

Position of rig : LAT 53°46.4'N. LONG 3°42.3'W (RIG 10)

Depth of water : 37m below chart datum

Tidal heights, in metres above chart datum, at Hilbre Island :

MHWS	MHWN	MLWN	MLWS
8.6	6.7	2.5	0.8

Meter	Type	Height above sea floor (m)	Recording interval (min)
1747	Aanderaa RCM4 in bottom mounted current meter/tide gauge	0.7	10

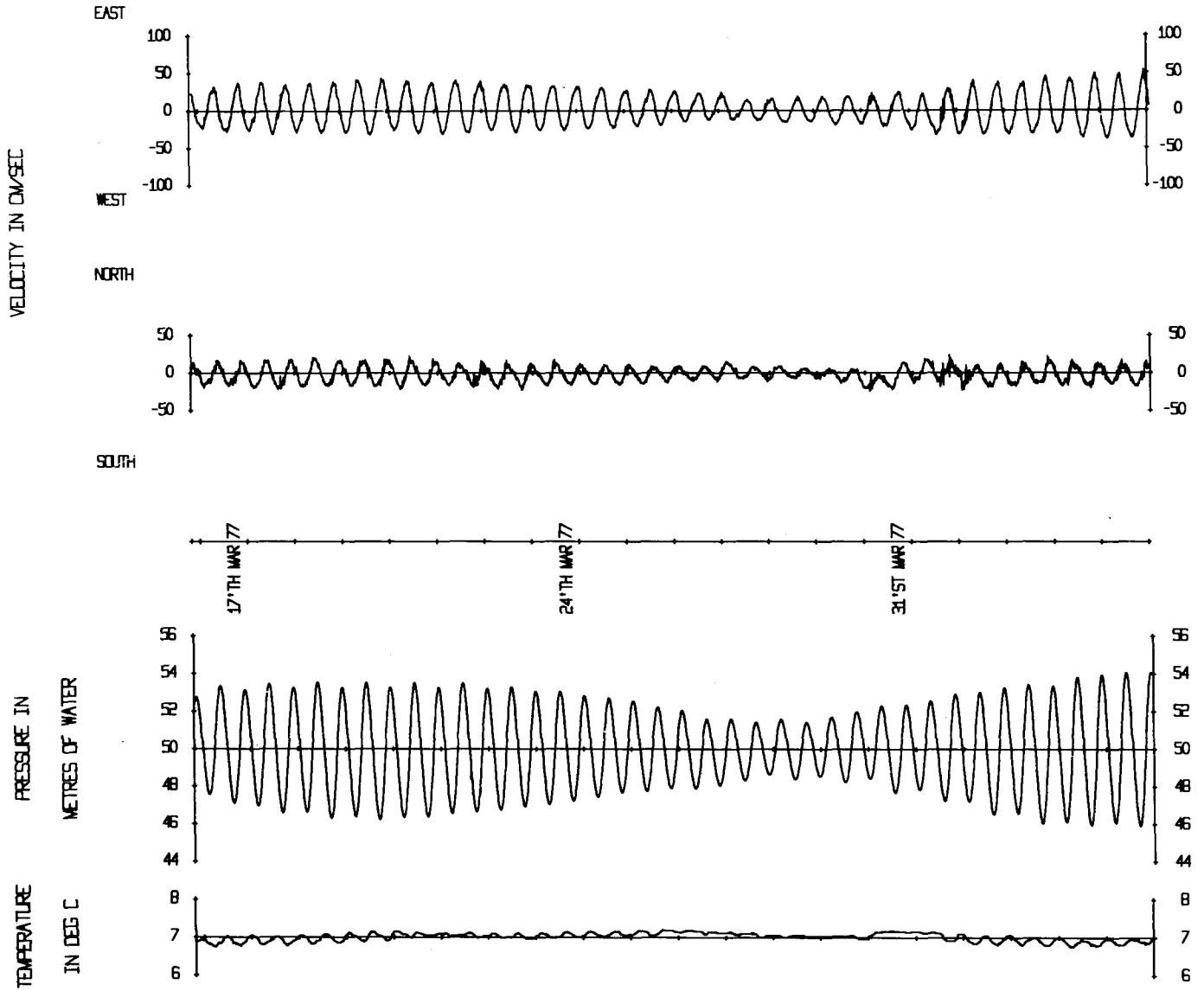
Rig set : 19.16 GMT 16 March 1977 from R.R.S. 'John Murray'

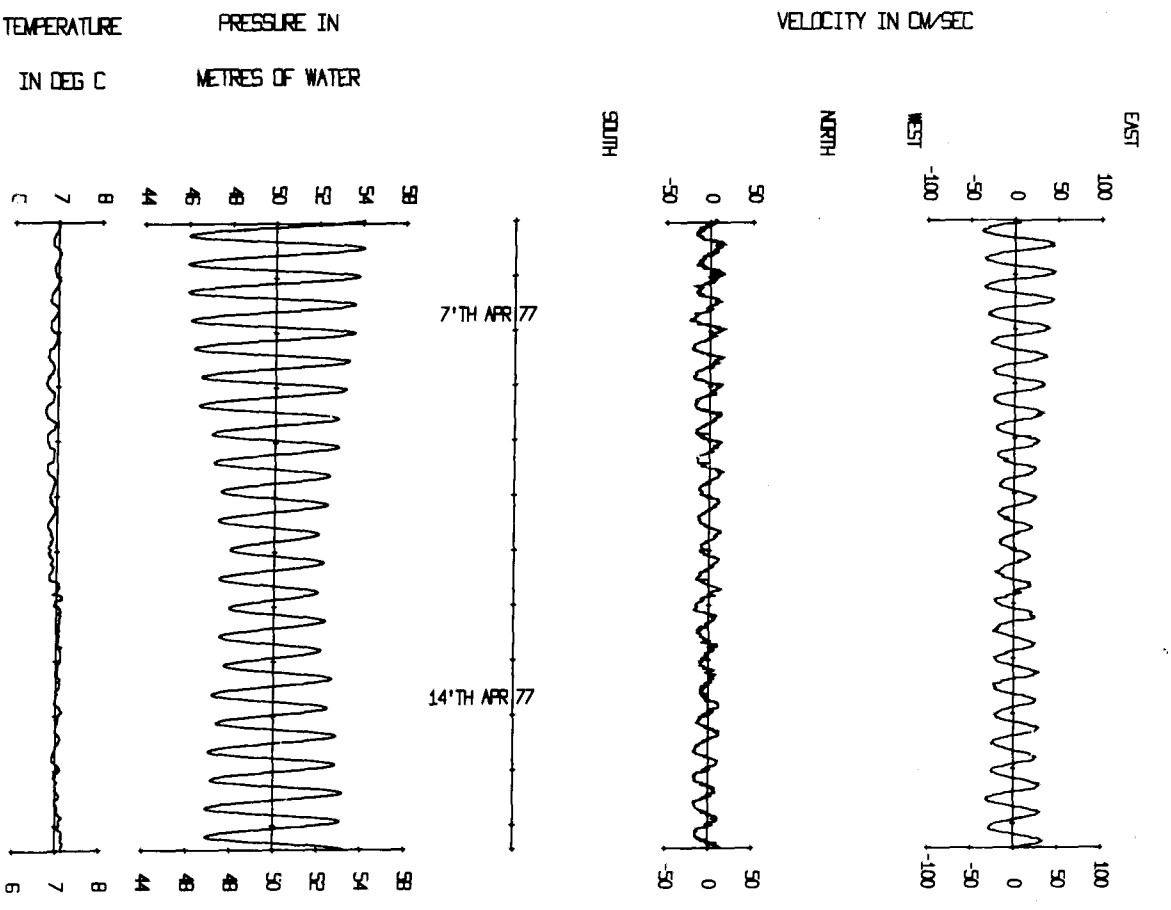
Rig recovered : 10.42 GMT 17 April 1977 from R.R.S. 'John Murray'

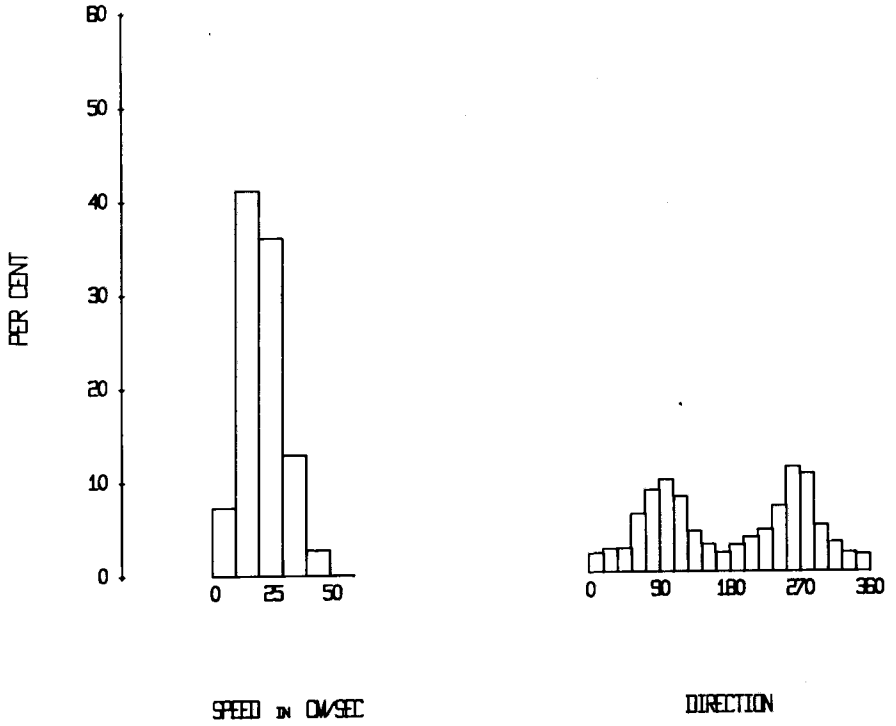
Mooring : Standard for bottom mounted current meter/tide gauge rig. The surface buoy was fitted with an experimental radar reflector.

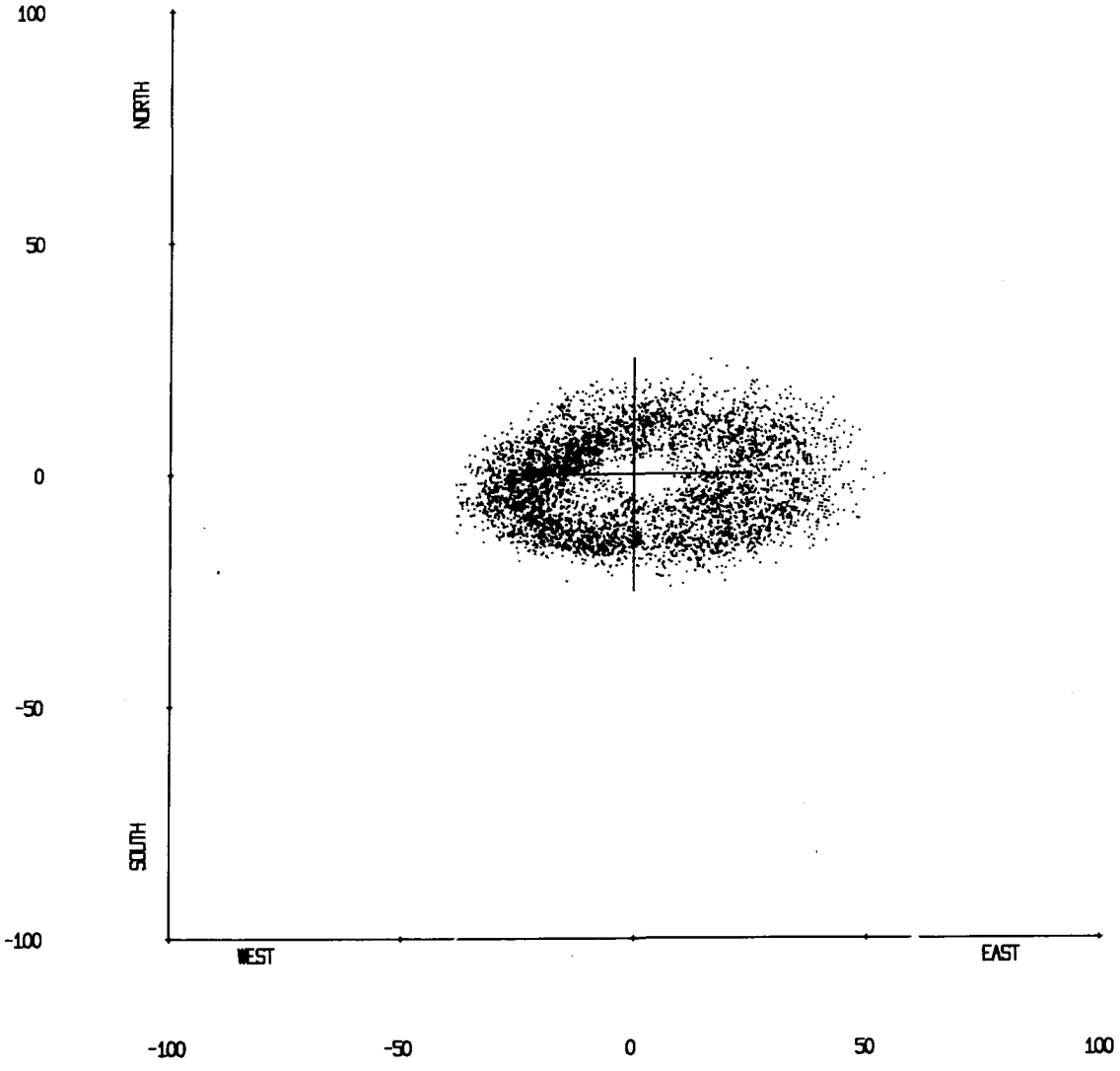
Comments : The launch and recovery were successfully accomplished at the first attempt.

Meter	:	Aanderaa 1747
Tape number	:	1747/6
Meter started	:	16.00.00 GMT 3 March 1977
Meter stopped	:	13.59.42 GMT 3 May 1977
Total number of readings	:	8773
Timing error	:	18 s fast
Start of useful record	:	19.30 GMT 16 March 1977
End of useful record	:	10.30 GMT 17 April 1977
Length of useful record	:	759 h
Comments	:	Good record. The pressure record is from the accompanying tide gauge and includes atmospheric pressure.


EAST
WEST
NORTH
SOUTH
VELOCITY IN CM/SEC
100
50
0
-50
-100
17'TH MAR 77
24'TH MAR 77
31'ST MAR 77
PRESSURE IN METRES OF WATER
56
54
52
50
48
46
44
TEMPERATURE IN DEG C
8
7
6


TEMPERATURE
IN DEG C
PRESSURE IN
METRES OF WATER
VELOCITY IN CM/SEC
SOUTH
NORTH
WEST
EAST
7'TH APR 77
14'TH APR 77


PER CENT
60
50
40
30
20
10
0
0
25
50
SPEED IN CM/SEC
0
90
180
270
360
DIRECTION


100
50
0
-50
-100
NORTH
SOUTH
WEST
EAST
-100
-50
0
50
100

14TH MAR 77
7TH MAR 77
31ST MAR 77
24TH MAR 77
17TH MAR 77
WEST
SOUTH
NORTH
EAST
-60
-50
-40
-30
-20
-10
0
10
-10
-20
-30
-40
-50

14TH MAR 77
7TH MAR 77
31ST MAR 77
24TH MAR 77
17TH MAR 77

Mooring number : 123

Position of rig : LAT. 53°46.1'N 3°55.4'W (RIG 11)

Depth of water : 40m below chart datum

Tidal heights, in metres above chart datum, at Hilbre Island : MHWS 8.6, MHWN 6.7, MLWN 2.5, MLWS 0.8

Meter	Type	Height above sea floor (m)	Recording interval (min)
2573	Aanderaa RCM4	25	10
568	Aanderaa RCM4	16	10
1001	Aanderaa RCM4	8	10

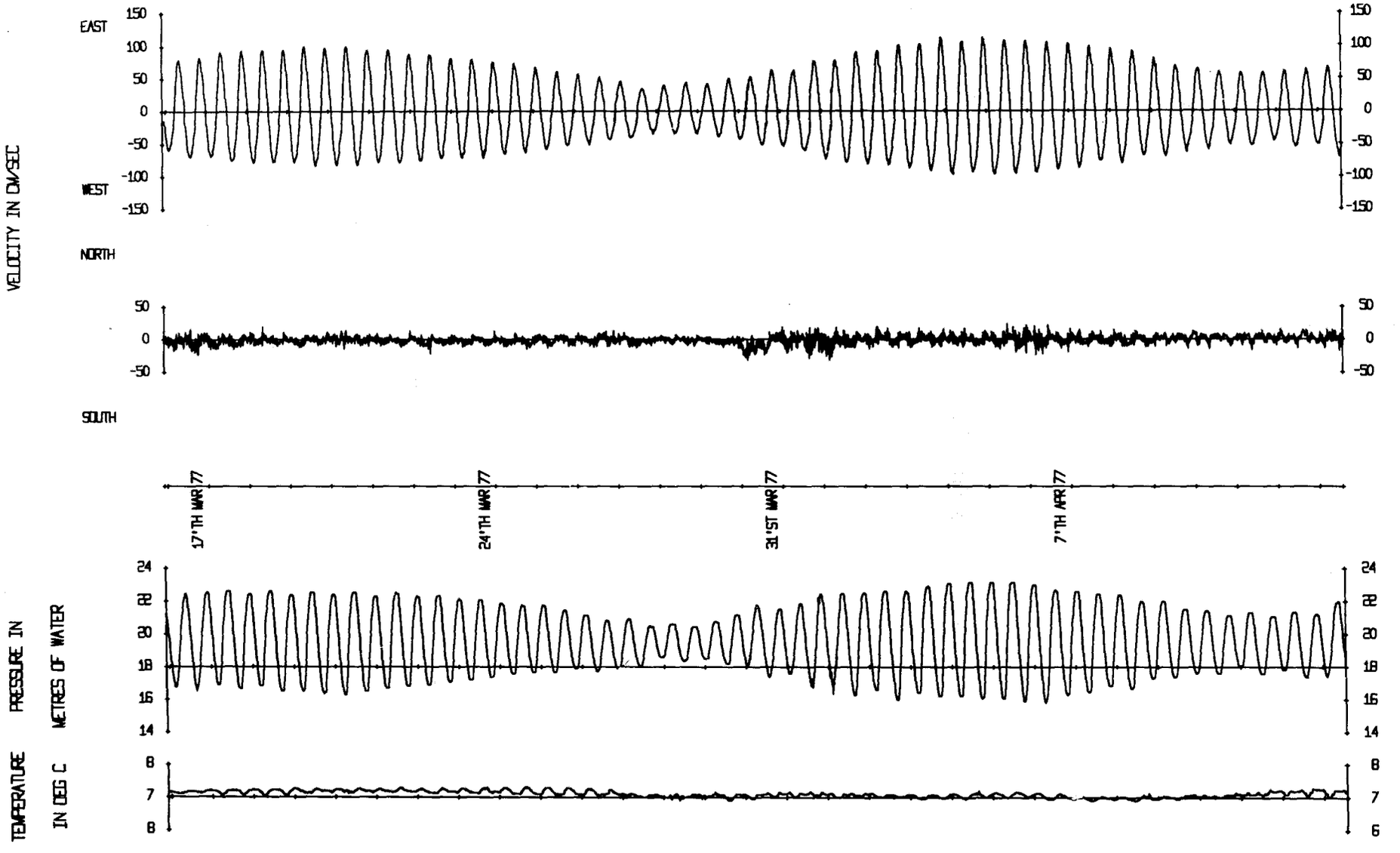
Rig set : 21.42 GMT 16 March 1977 from R.R.S. 'John Murray'

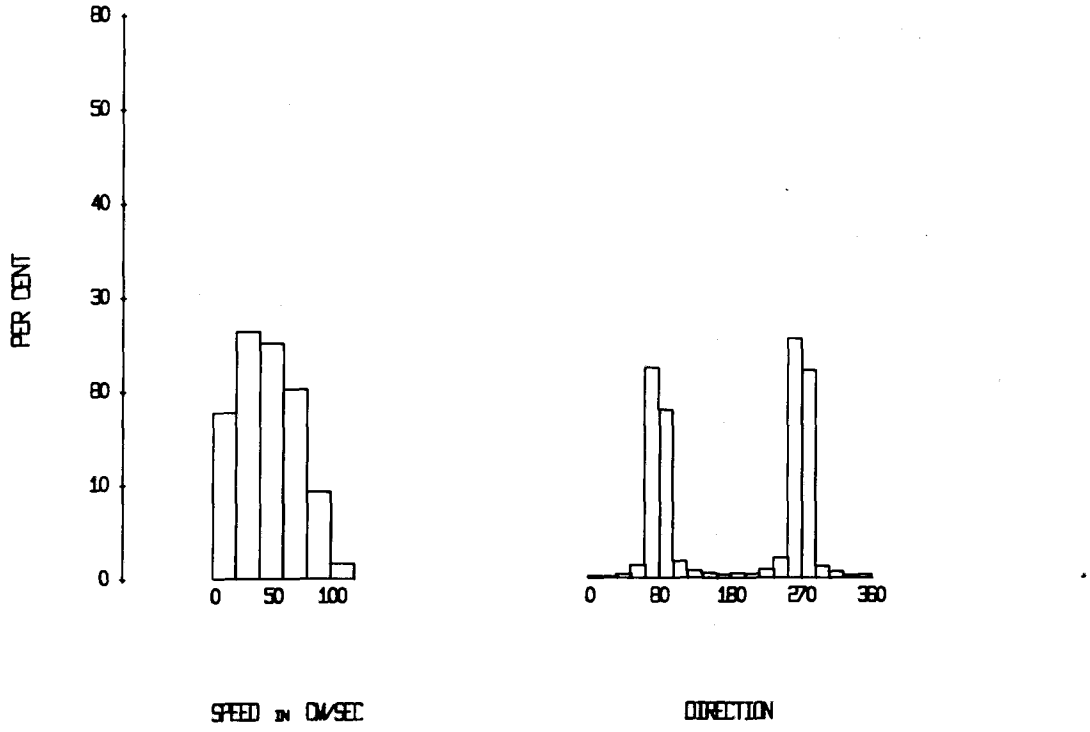
Rig recovered : 6 May 1977

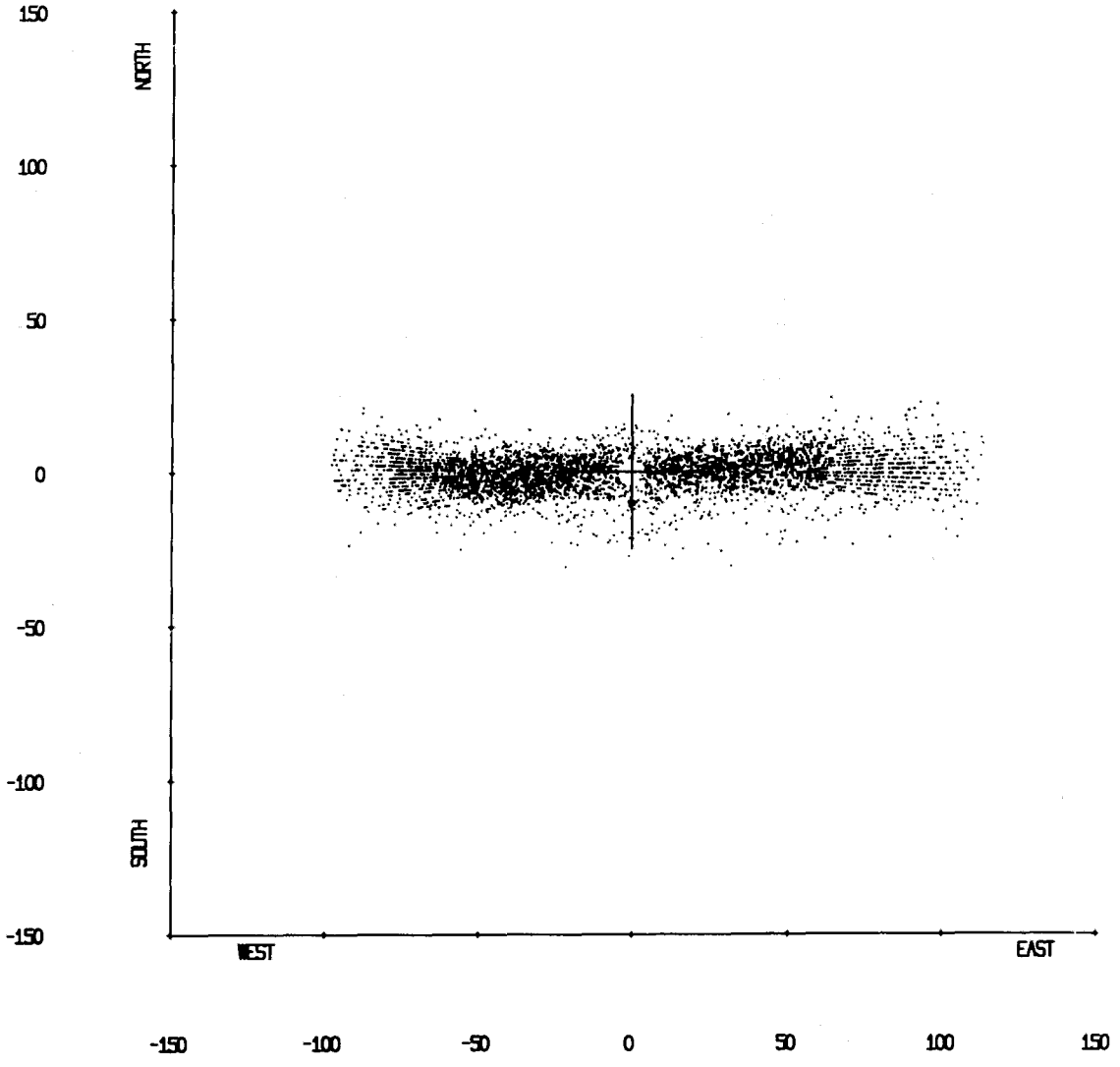
Mooring : Standard with 1m sub-surface buoy

Comments : The launch was successfully accomplished at the first attempt. During April the trawler 'Fred Wood' landed the surface buoy at Kircudbright. Three drag and acoustic searches, each lasting 4 hours were executed on 18, 19 and 26 April, without success. On 6 May 1977 a fishing vessel recovered the sub-surface buoy and the top two current meters floating free 2km off Windscale. The current meter records show that the rig was molested at 13.10 on 14 April.

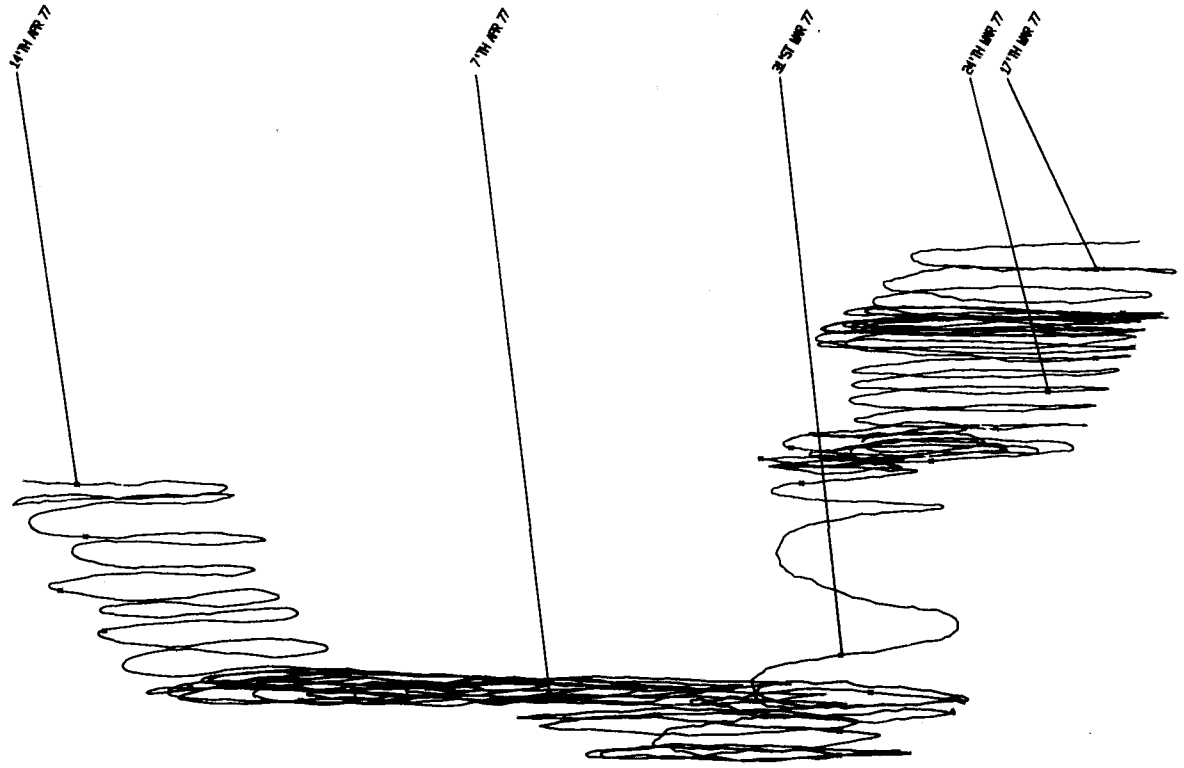
Meter	: Aanderaa 2573
Tape number	: 2573/1
Meter started	: 19.18.53 GMT 16 March 1977
Meter stopped	: 10.19.05 GMT 14 May 1977
Total number of readings	: 8443
Timing error	: 12 s slow
Start of useful record	: 21.49 GMT 16 March 1977
End of useful record	: 12.49 GMT 14 April 1977
Length of useful record	: 687 h
Comments	: Good record. The meter was fitted with a 0-100 PSI pressure sensor and a new Aanderaa spindle. When it was returned to Bidston its rotor was missing and its spindle bent.


VELOCITY IN CM/SEC
EAST
WEST
NORTH
SOUTH
150
100
50
0
-50
-100
-150
17'TH MAR 77
24'TH MAR 77
31'ST MAR 77
7'TH APR 77
PRESSURE IN
METRES OF WATER
TEMPERATURE
IN DEG C
24
22
20
18
16
14
8
7
6

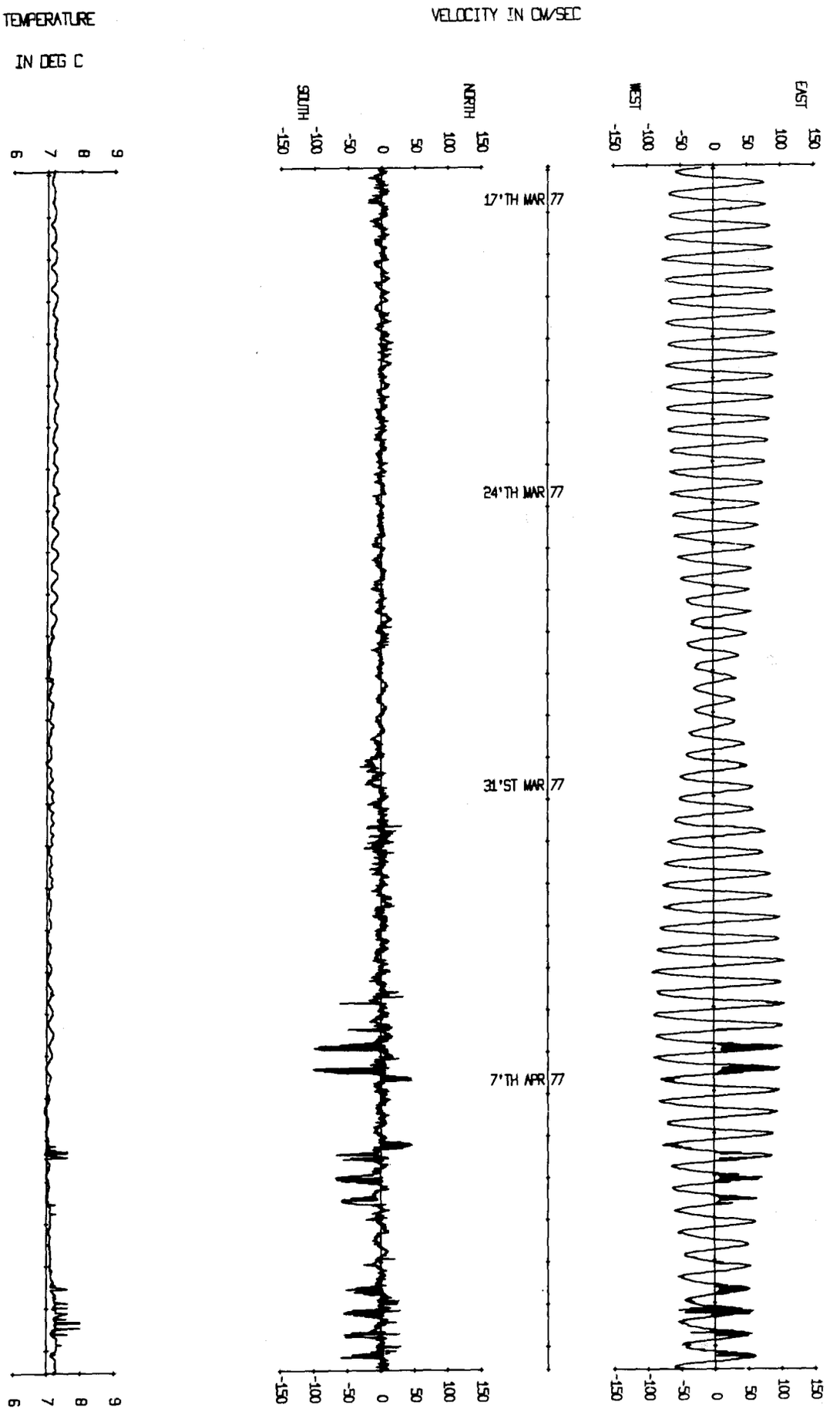

PER CENT
80
50
40
30
80
10
0
0
50
100
0
80
180
270
360
SPEED IN CM/SEC
DIRECTION

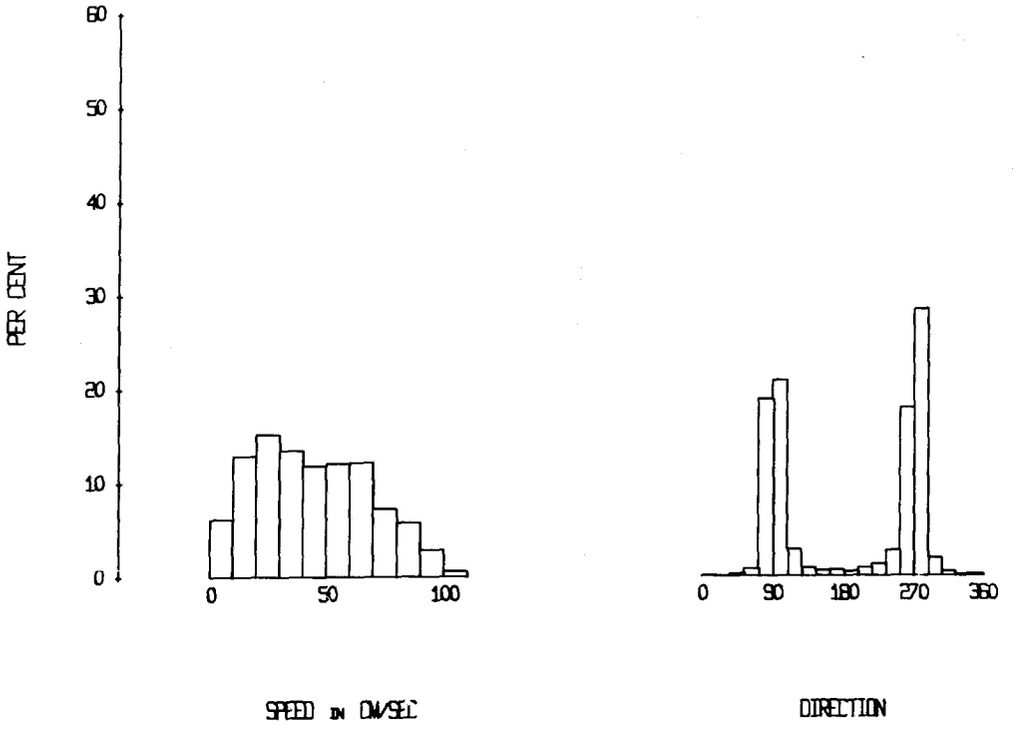

150
100
50
0
-50
-100
-150
NORTH
SOUTH
WEST
EAST
-150
-100
-50
0
50
100
150

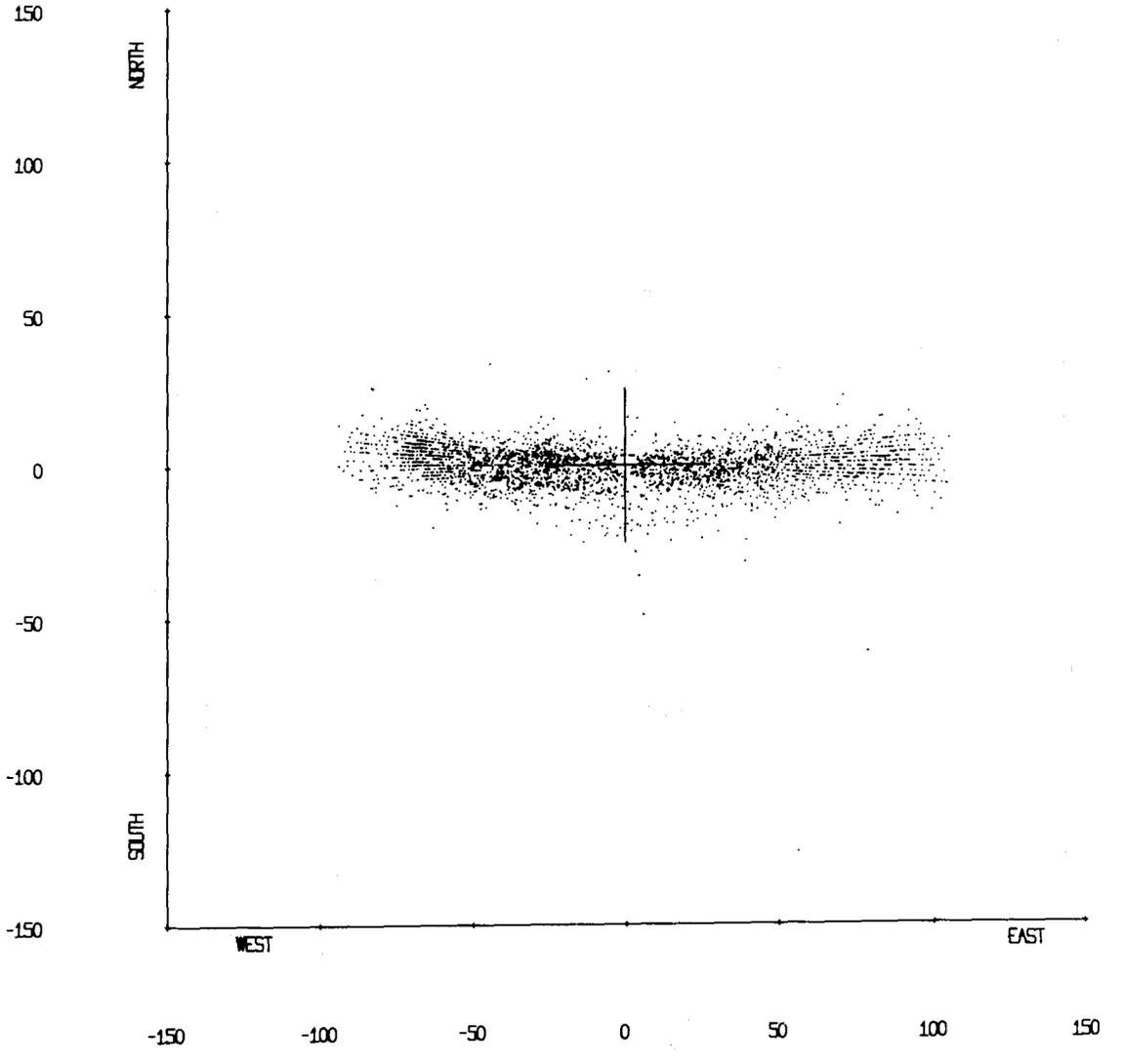

7TH APR 77
31ST MAR 77
24TH MAR 77
17TH MAR 77
NORTH
SOUTH
WEST
EAST
-45
-40
-35
-30
-25
-20
-15
-10
-5
0
5
-5
-10
-15
-20
-25

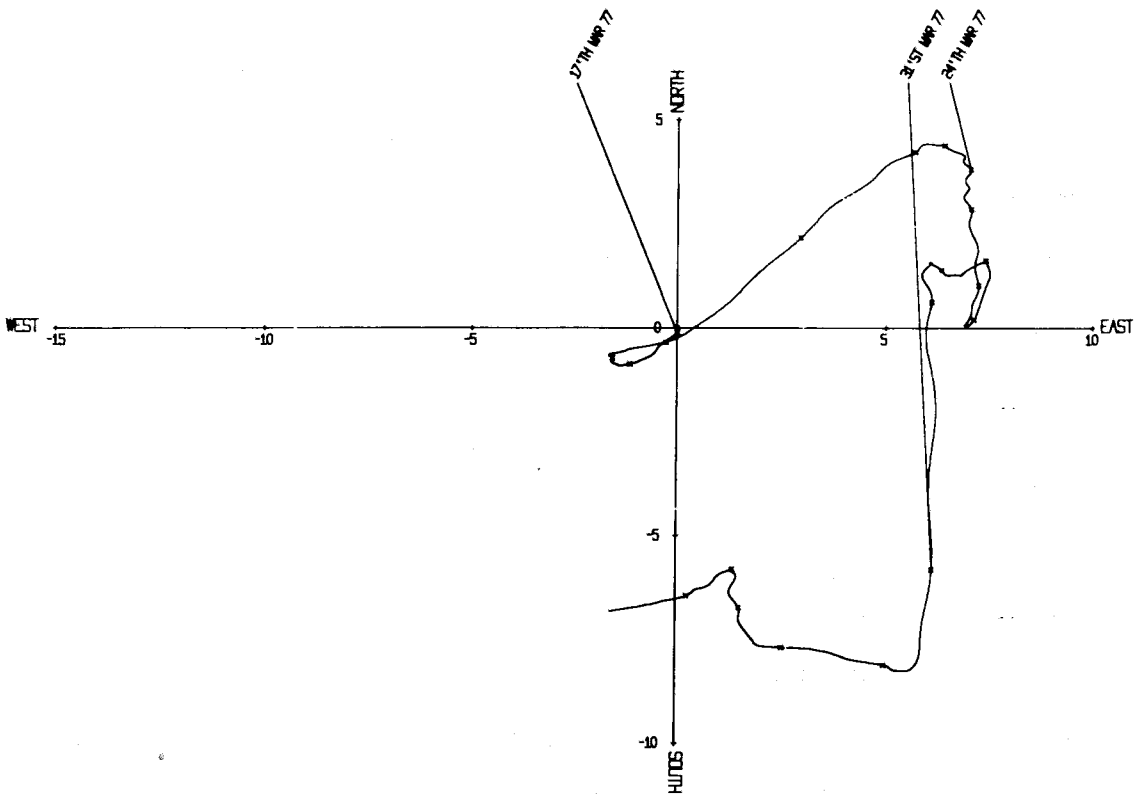

14TH APR 77
7TH APR 77
31ST MAR 77
24TH MAR 77
17TH MAR 77

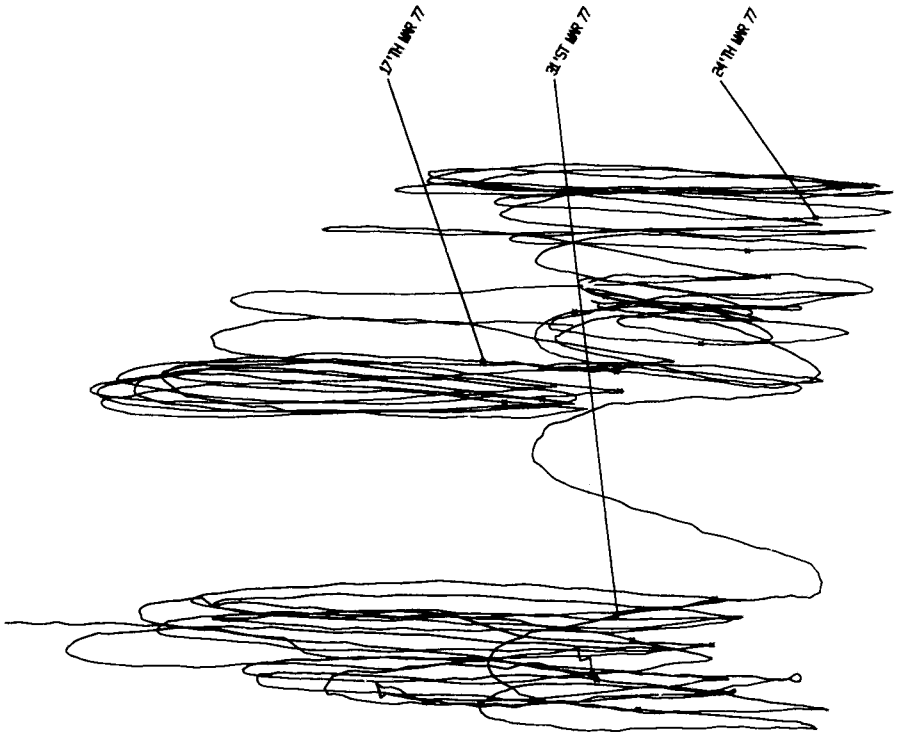
Meter	: Aanderaa 568
Tape number	: 568/6
Meter started	: 19.28.53 GMT 16 March 1977
Meter stopped	: 10.39.41 GMT 14 May 1977
Total number of readings	: 8444
Timing error	: 48s slow
Start of useful record	: 21.59 GMT 16 March 1977
End of useful record	: 18.59 GMT 6 April 1977
Length of useful record	: 501 h
Comments	: The meter was fitted with a modified spindle. When it was returned to Bidston its rotor was missing and its spindle bent. The encoder was dirty and noisy and the record had to be shortened by a week because there were many encoding faults. The full record is shown for the plot of north and east components of velocity and temperature against time but only the shortened version for the rest. There was an above average number of errors in the record.


TEMPERATURE
IN DEG C
6
7
8
9
VELOCITY IN CM/SEC
SOUTH
NORTH
-150
-100
-50
0
50
100
150
17'TH MAR 77
24'TH MAR 77
31'ST MAR 77
7'TH APR 77
WEST
EAST


PER CENT
60
50
40
30
20
10
0
0
50
100
0
90
180
270
360
SPEED IN CM/SEC
DIRECTION


150
100
50
0
-50
-100
-150
NORTH
SOUTH
WEST
EAST
-150
-100
-50
0
50
100
150


17TH MAR 77
31ST MAR 77
24TH MAR 77
NORTH
SOUTH
WEST
EAST
5
0
-5
-10
-15
-10
-5
5
10


17TH MAR 77
31ST MAR 77
24TH MAR 77

Meter	:	Aanderaa 1001
Tape number	:	1001/4
Meter started	:	19.48.53 GMT 16 March 1977
Meter stopped	:	-
Total number of readings	:	-
Timing error	:	-
Start of useful record	:	-
End of useful record	:	-
Length of useful record	:	-
Comments	:	The meter was fitted with an Aanderaa spindle. It was not recovered.

Mooring number : 124

Position of rig : LAT 53°23.6'N LONG 3°45.5'W (RIG 1)

Depth of water : 21m below chart datum

Tidal heights, in metres above chart datum, at Hilbre Island :

MHWS	MHWN	MLWN	MLWS
8.6	6.7	2.5	0.8

Meter	Type	Height above sea floor (m)	Recording interval (min)
416	Aanderaa RCM4	5	10

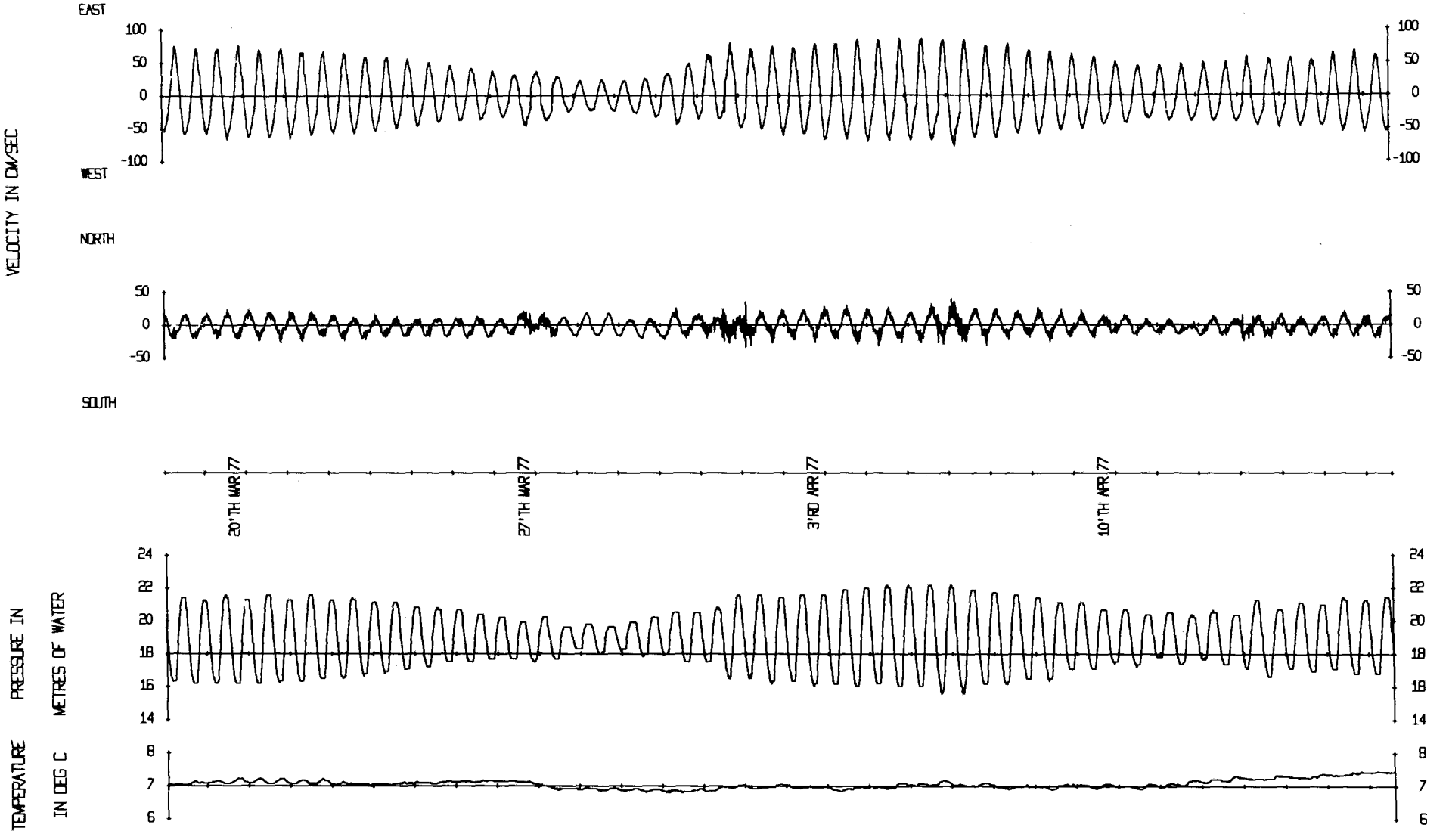
Rig set : 01.00 GMT 19 March 1977 from RRS 'John Murray'

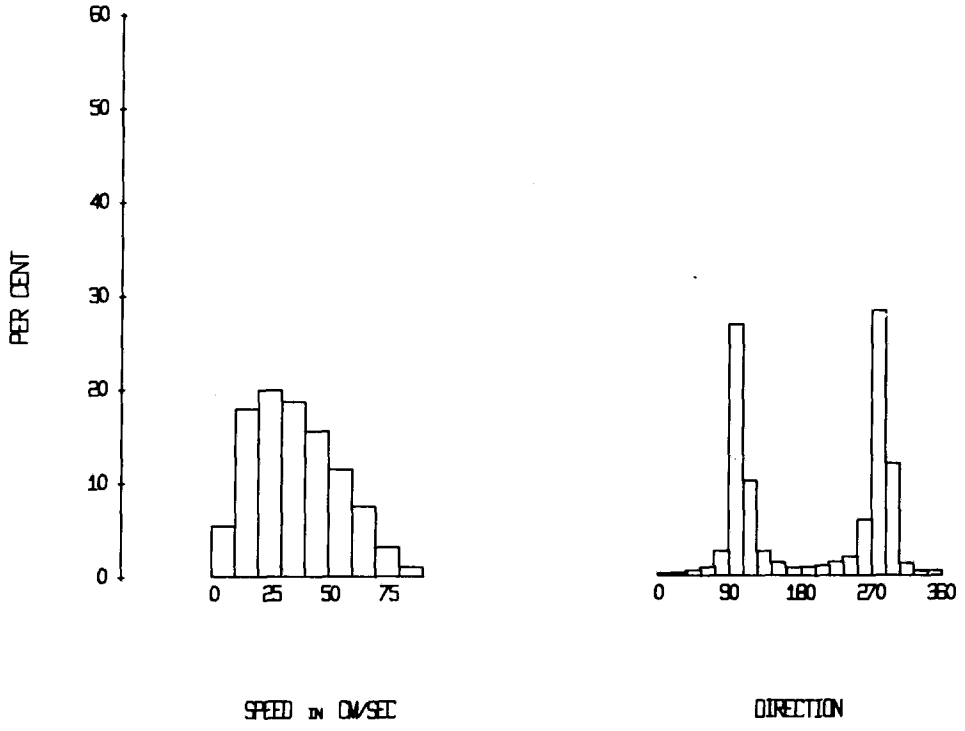
Rig recovered : 14.37 GMT 17 April 1977 from RRS 'John Murray'

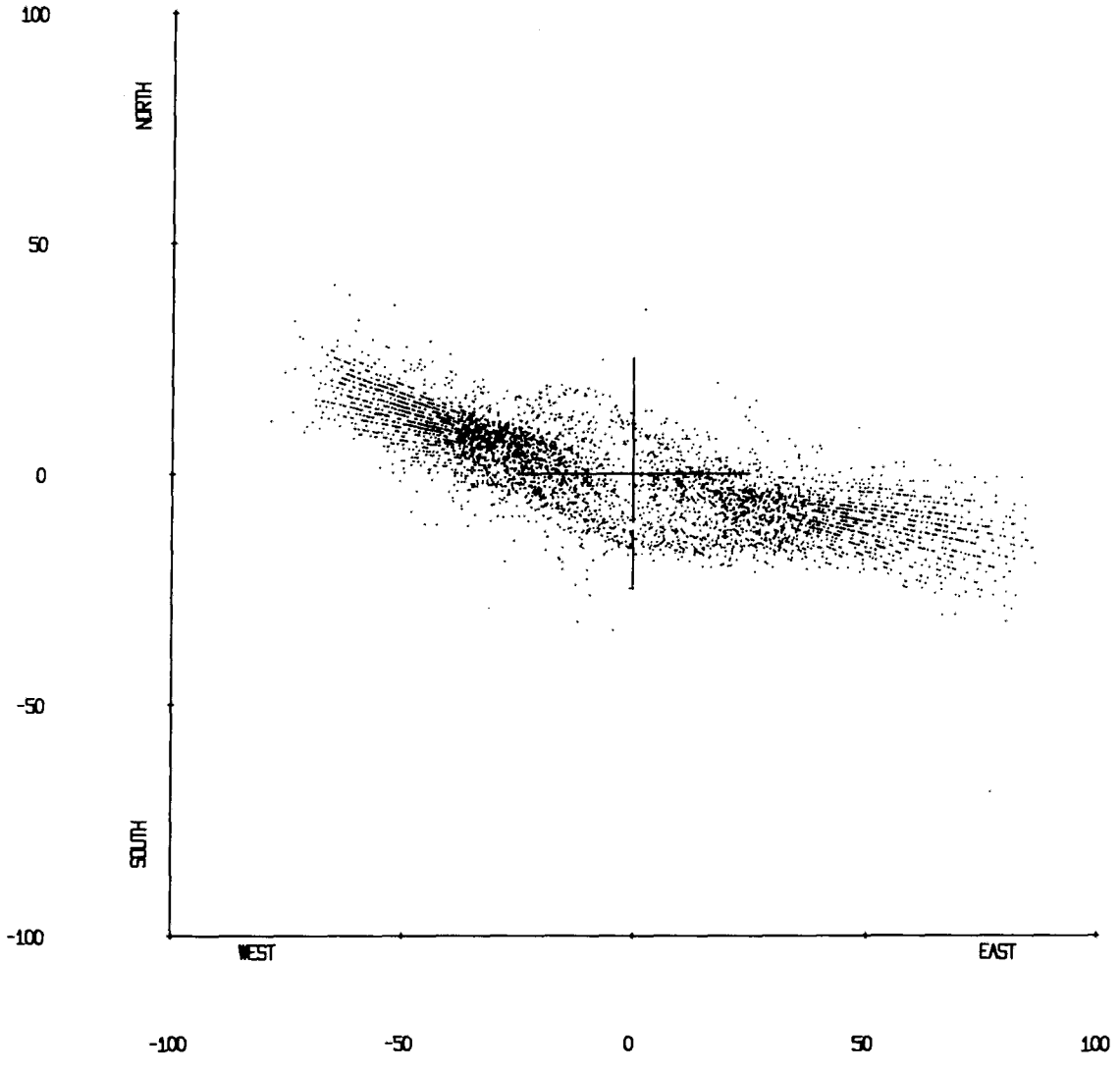
Mooring : Standard

Comments : The launch and recovery were successfully accomplished at the first attempt

Meter	: Aanderaa 416	
Tape number	: 416/6	
Meter started	: 23.10.00 GMT	18 March 1977
Meter stopped	: 16.21.47 GMT	17 April 1977
Total number of readings	: 4280	
Timing error	: 107s slow	
Start of useful record	: 01.10 GMT	19 March 1977
End of useful record	: 14.22 GMT	17 April 1977
Length of useful record	: 709 h	
Comments	: Good record. The meter was fitted with a 0-200 PSI pressure sensor and a modified spindle. It was recovered in good condition. There were no errors in this record.	


EAST
WEST
NORTH
SOUTH
VELOCITY IN CM/SEC
100
50
0
-50
-100
20'TH MAR 77
27'TH MAR 77
3'RD APR 77
10'TH APR 77
PRESSURE IN METRES OF WATER
24
22
20
18
16
14
TEMPERATURE IN DEG C
8
7
6


PER CENT
60
50
40
30
20
10
0
0
25
50
75
SPEED IN CM/SEC
0
90
180
270
360
DIRECTION


100
50
0
-50
-100
NORTH
SOUTH
WEST
EAST
-100
-50
0
50
100

2ND MAR 77
10TH MAR 77
3RD MAR 77
20TH MAR 77
NORTH
WEST
EAST
HUTTS
-25
-20
-15
-10
-5
0
5
-5
-10
-15

15TH MAR 77
25TH MAR 77
9TH MAR 77
2ND MAR 77
19TH MAR 77

Mooring number : 125

Position of rig : LAT 53°46.4' N LONG 4°8.1'W (RIG 12)

Depth of water : 42m below chart datum

Tidal heights, in metres above chart datum, at Hilbre Island :

MHWS	MHWN	MLWN	MLWS
8.6	6.7	2.5	0.8

Meter	Type	Height above sea floor (m)	Recording interval (min)
1507	Aanderaa RCM4 in bottom mounted current meter/tide gauge	0.7	10

Rig set : 11.45 GMT 19 March 1977 from R.R.S. 'John Murray'

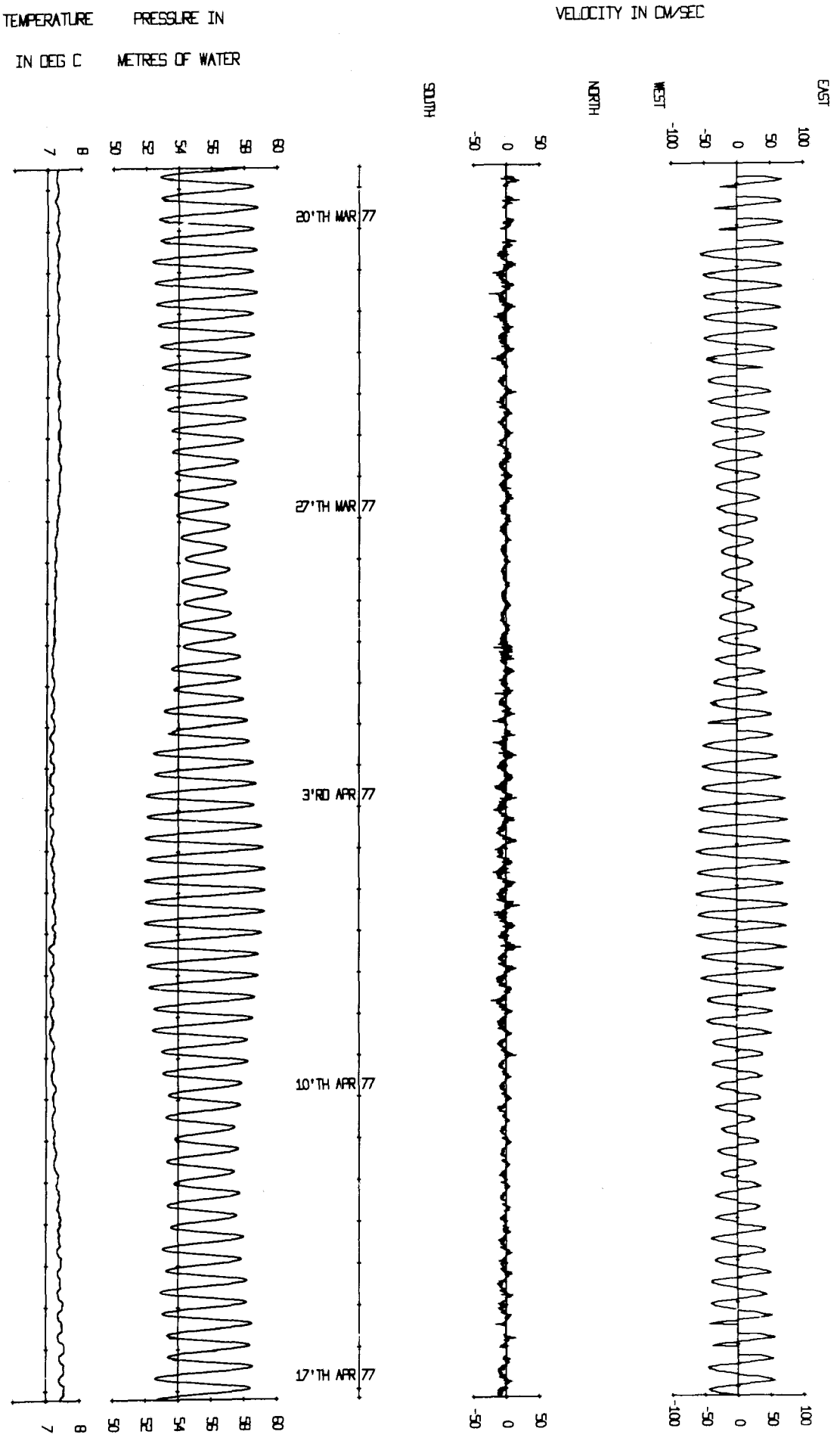
Rig recovered : 05.26 GMT 18 April 1977 from R.R.S. 'John Murray'

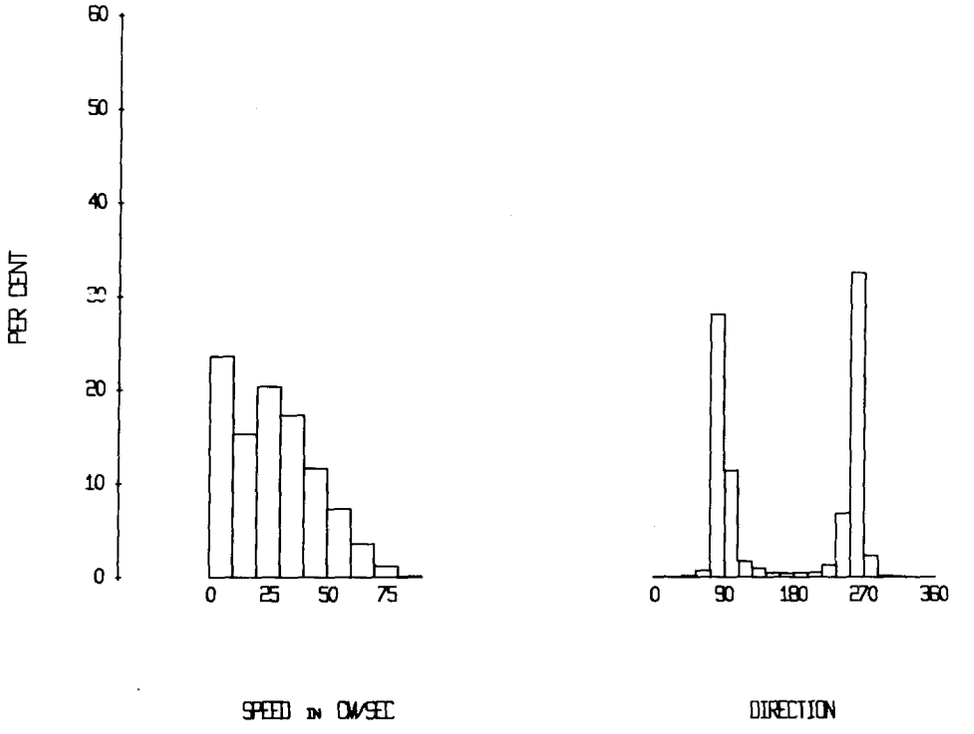
Mooring : Standard for bottom mounted current meter/tide gauge.

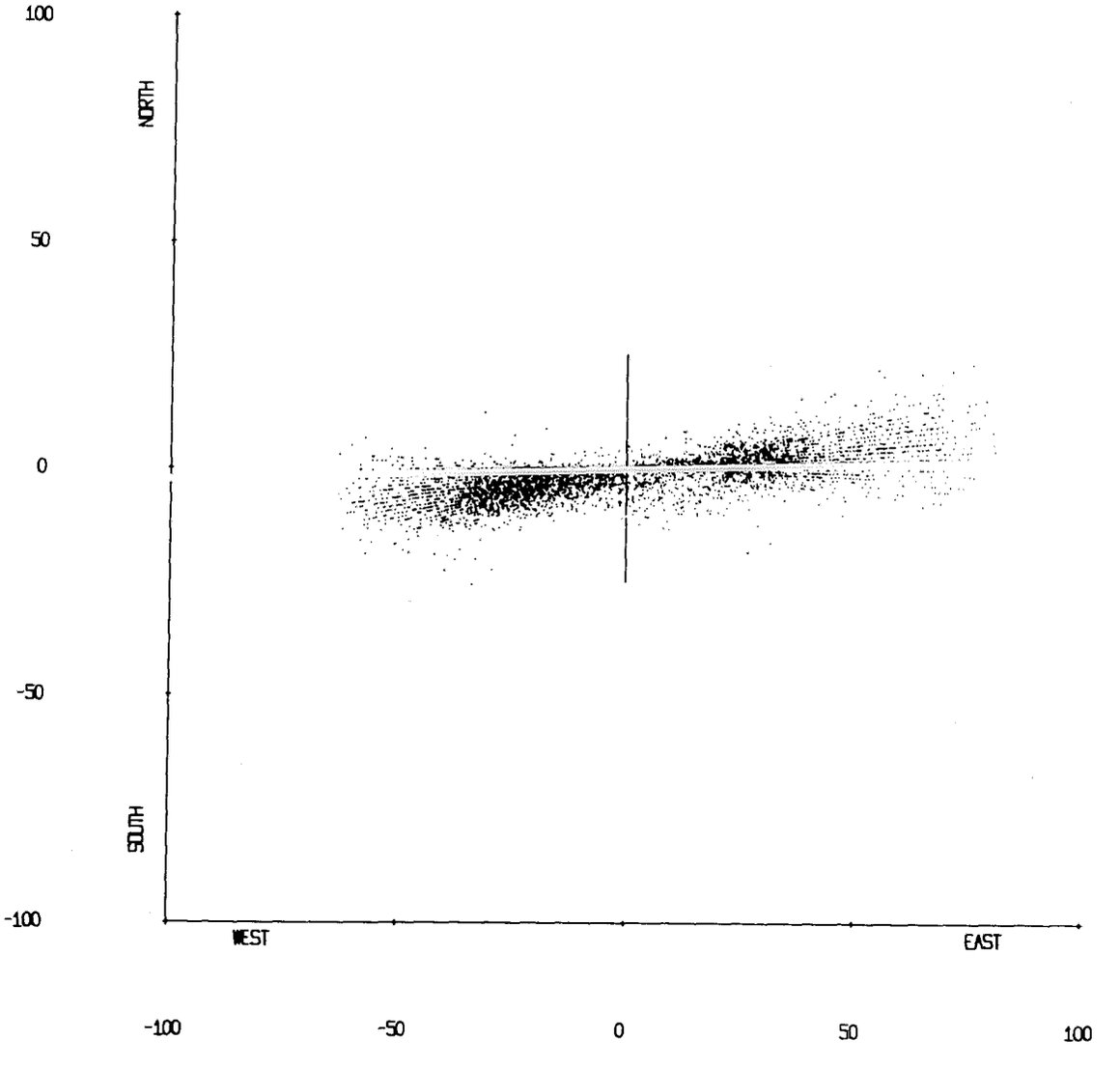
Comments : The launch was first attempted on 16 March but the polypropylene ground line caught under the stern chute and was cut. Since the sea was becoming increasingly rough the launch was postponed and successfully carried out on 19 March. The recovery was completed without difficulty.

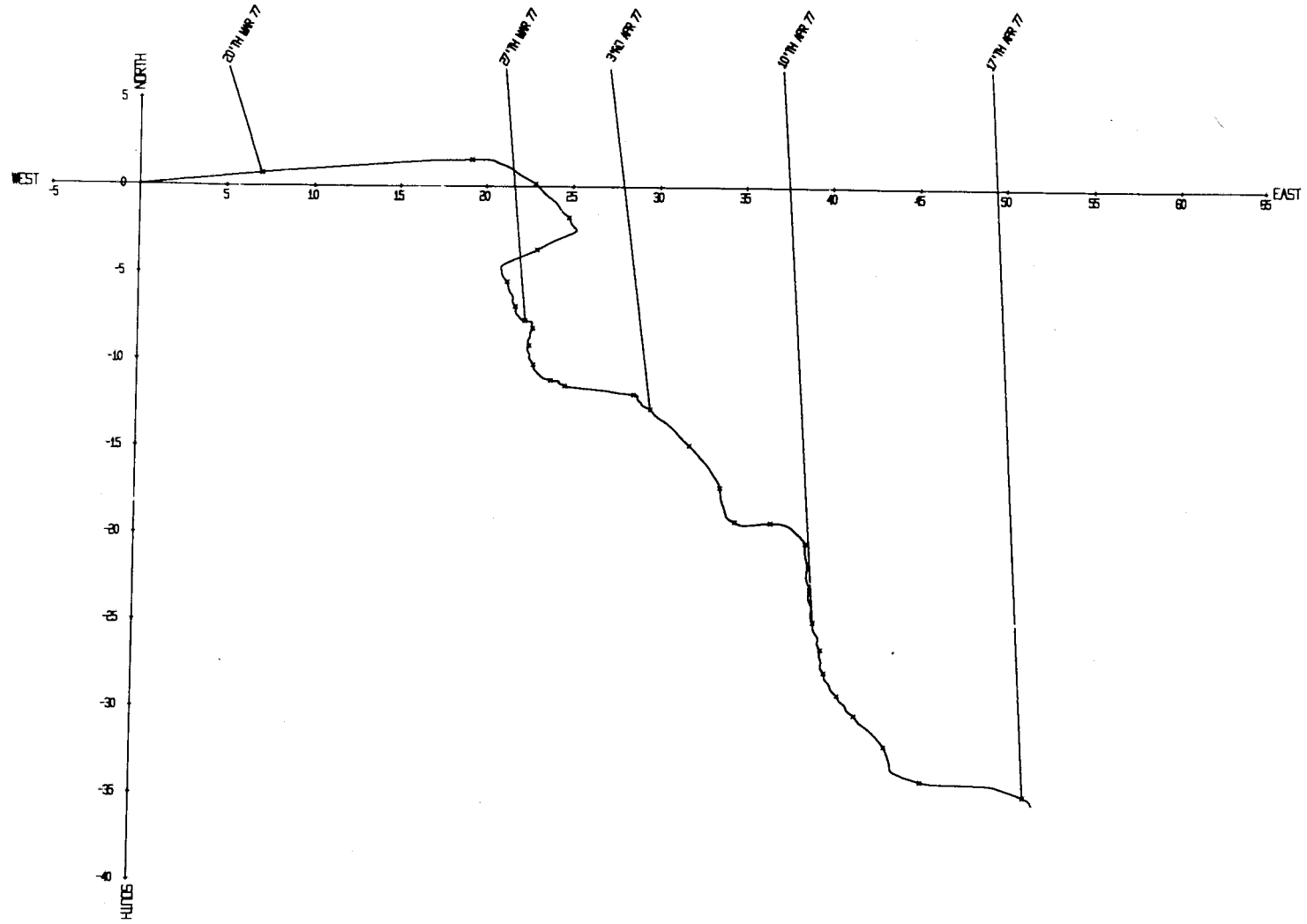
An experimental rig (mooring number 132) was deployed 0.5 km from the rig on 17 April and recovered shortly after mooring 125. The experimental rig contained a bottom mounted current meter (no 302) and a toroid with a 'Lensref" radar reflector.

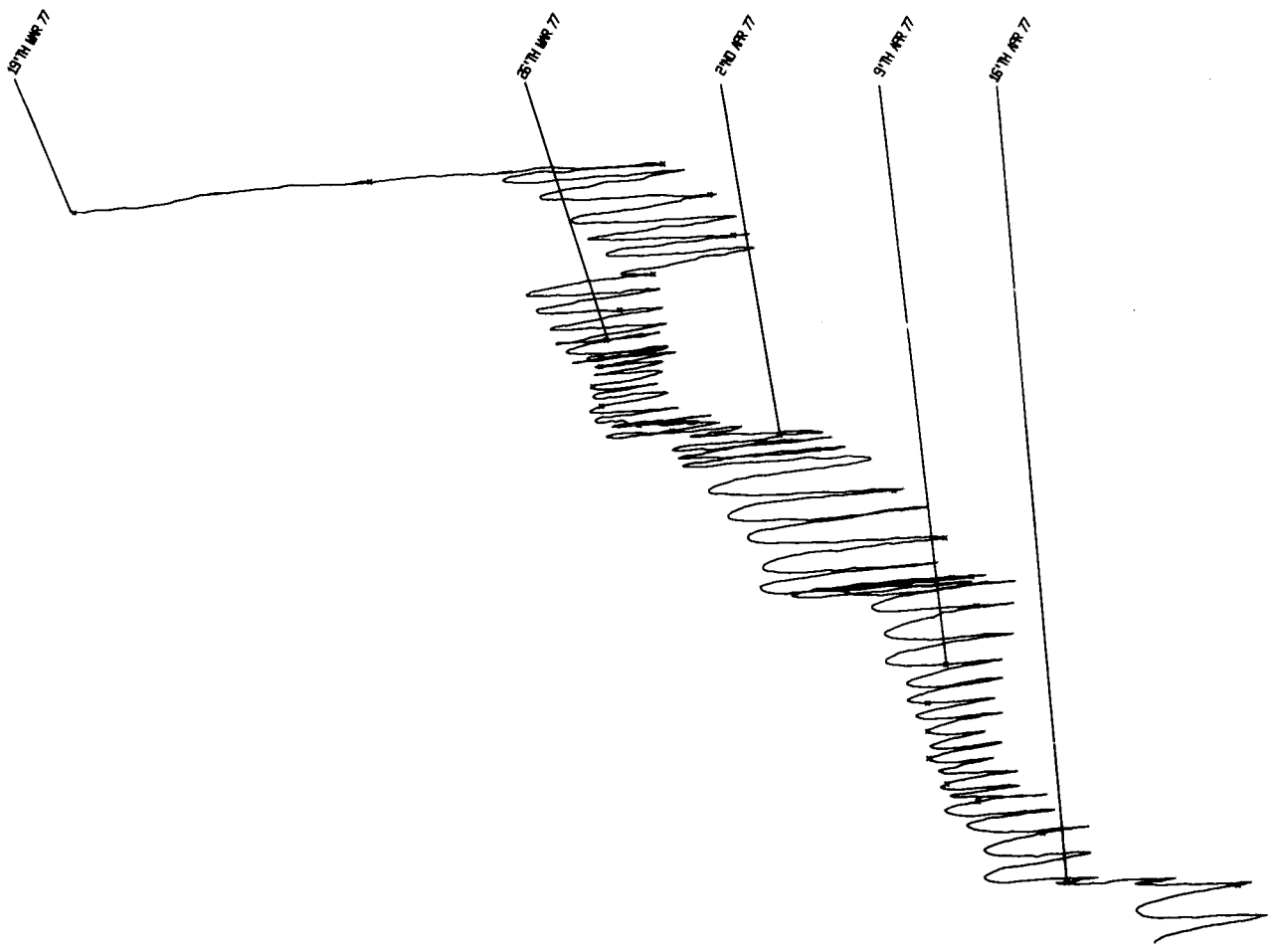
Meter	: Aanderaa 1507	
Tape number	: 1507/2	
Meter started	: 11.30.00 GMT	4 March 1977
Meter stopped	: 08.59.50 GMT	4 May 1977
Total number of readings	: 8770	
Timing error	: 10s fast	
Start of useful record	: 12.00 GMT	19 March 1977
End of useful record	: 05.10 GMT	18 April 1977
Length of useful record	: 624 h	
Comments	: Near the beginning, in the middle and near the end of its stay on the sea floor the frame rocked onto its side and back upright, so that good data is from 07.40 on 21 March till 00.10 on 2 April and 04.40 on 2 April until 12.20 on 16 April. For the times the meter was on its side zeroes have been inserted into the velocity record. The full record has been displayed in all plots. When the meter was recovered there was some seaweed round the top bearing of the rotor. The pressure record displayed is from the accompanying tide gauge and includes atmospheric pressure.	


TEMPERATURE
IN DEG C
PRESSURE IN
METRES OF WATER
VELOCITY IN CM/SEC
SOUTH
NORTH
WEST
EAST
20'TH MAR 77
27'TH MAR 77
3'RD APR 77
10'TH APR 77
17'TH APR 77


PER CENT
60
50
40
30
20
10
0
0
25
50
75
0
90
180
270
360
SPEED IN CM/SEC
DIRECTION


100
50
0
-50
-100
NORTH
SOUTH
WEST
EAST
-100
-50
0
50
100


20TH MAR 77
27TH MAR 77
3RD APR 77
10TH APR 77
17TH APR 77
NORTH
SOUTH
EAST
WEST
5
0
-5
5
10
15
20
25
30
35
40
45
50
55
60
65
-5
-10
-15
-20
-25
-30
-35
-40


19TH MAR 77
26TH MAR 77
2ND APR 77
9TH APR 77
16TH APR 77

Mooring number : 126

Position of rig : LAT 53°38.8'N LONG 4°21.8'W (RIG 8)

Depth of water : 59m below chart datum

Tidal heights, in metres above chart datum, at Hilbre Island :

MHWS	MHWN	MLWN	MLWS
8.6	6.7	2.5	0.8

Meter		Height above sea floor (m)	Recording interval (min)
566	AANDERAA RCM4	35	10
2574	AANDERAA RCM4	33	0.5
1139	AANDERAA RCM4	8	10

Rig set : 14.17 GMT 19 March from R R.S. 'John Murray'

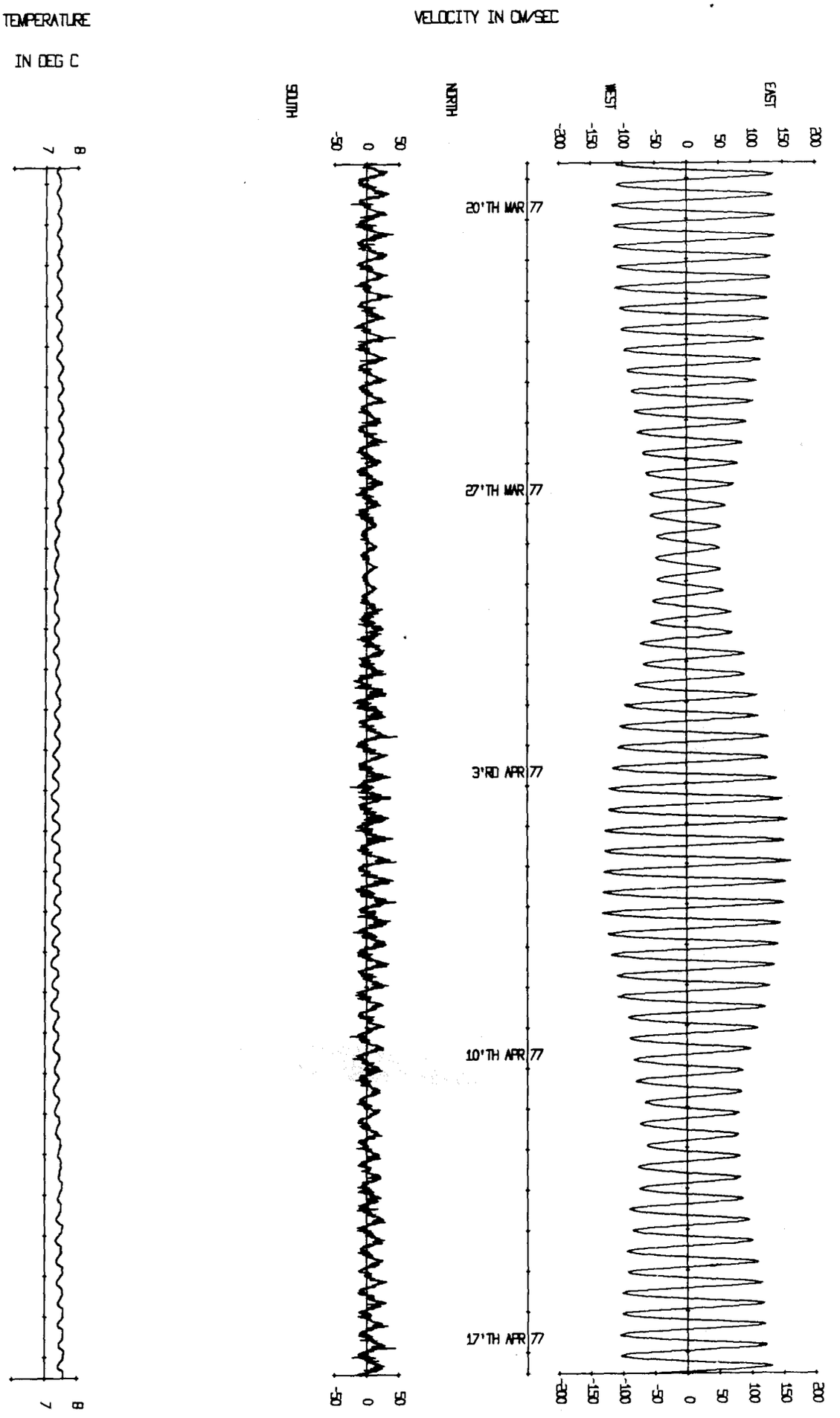
Rig recovered : 12.34 GMT 18 April from R.R.S. 'John Murray'

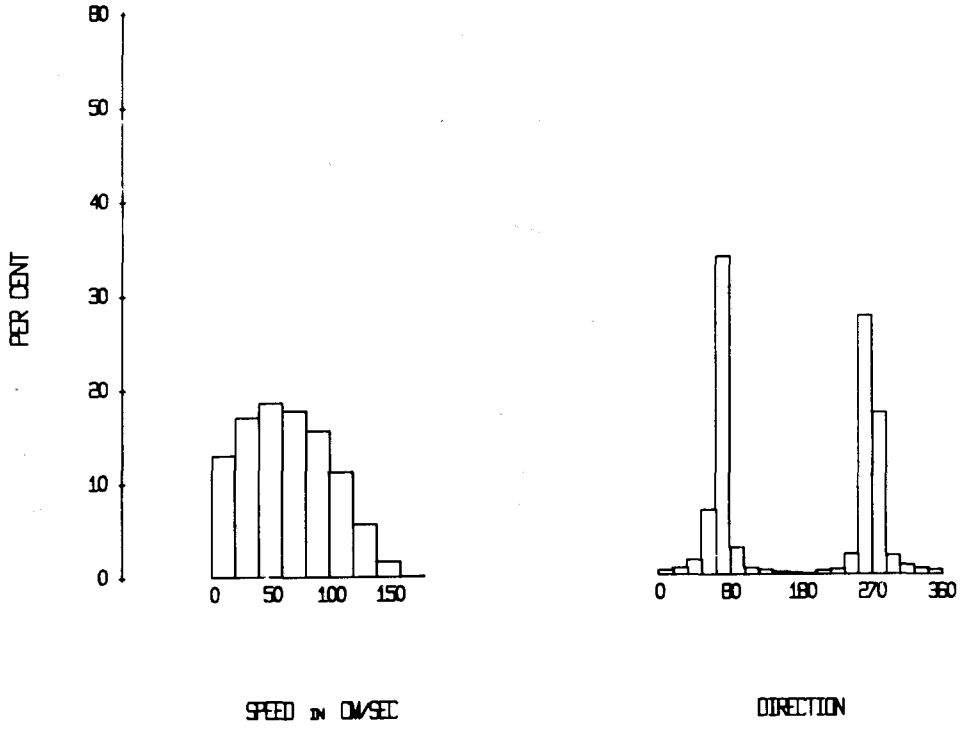
Mooring : Standard

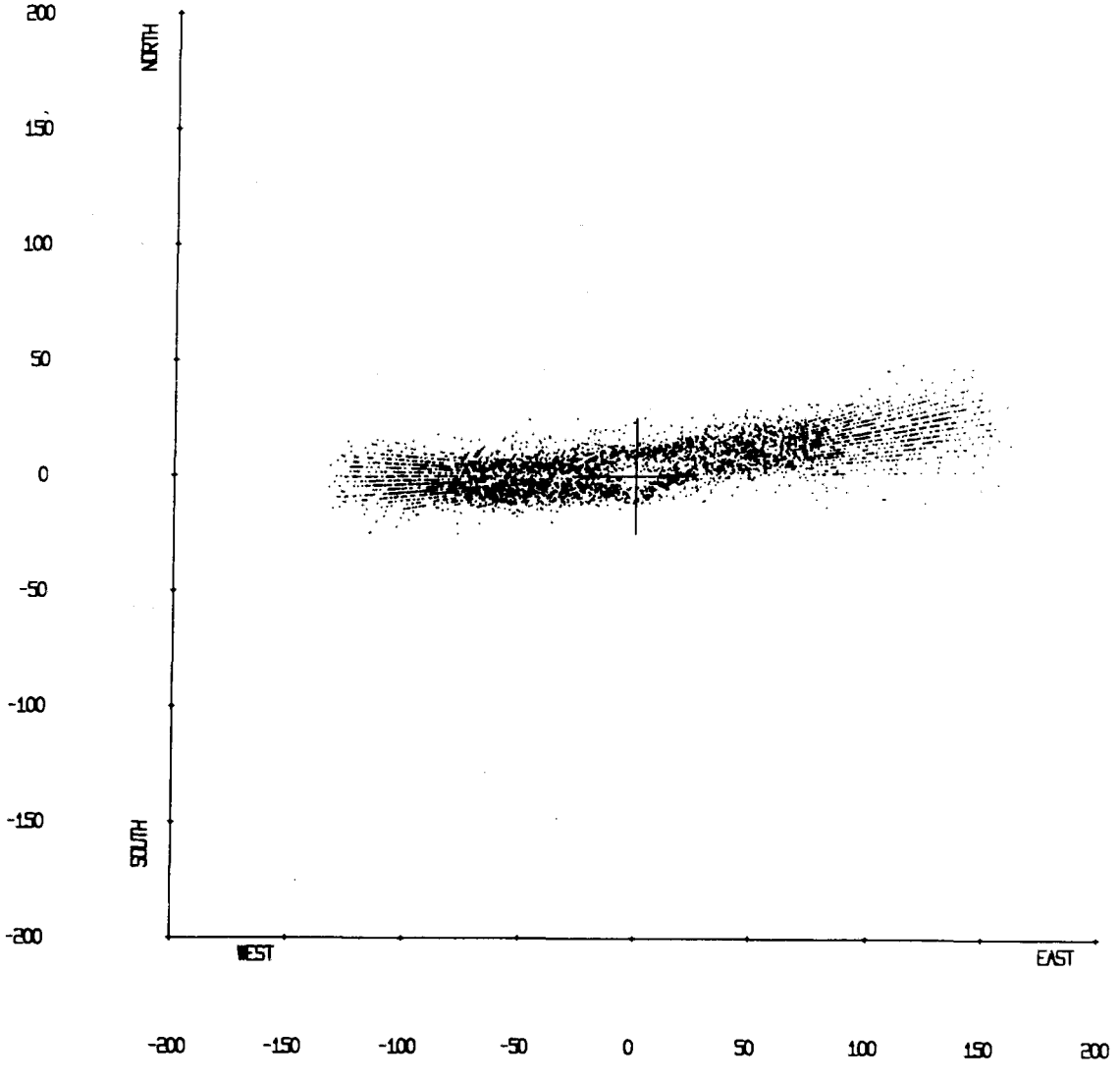
Comments : The launch was successfully accomplished at the first attempt. No surface buoy was present when the rig was visited on 17 April, but the pellet floats above the sub-surface buoy were visible on station. Dragging was performed for 1½ hours without result. Dragging was again tried on 18 April and after 40 minutes the ground line caught and the rig recovered. The surface buoy line had been cut 5m above the anchor. The surface buoy was found floating free without its light on 1 May near the West Hoyle Buoy (53°25'N 3°20'W).

There is a discrepancy between depth at launch recorded on the ship (51m) and by the bottom two current meters (61m).

Meter	: Aanderaa 566
Tape number	: 566/4
Meter started	: 13.10.00 GMT 19 March 1977
Meter stopped	: 13.29.34 GMT 18 April 1977
Total number of readings	: 4323
Timing error	: 26s fast
Start of useful record	: 14.30 GMT 19 March 1977
End of useful record	: 12.20 GMT 18 April 1977
Length of useful record	: 717 h
Comments	: Good record. The meter was fitted with an Aanderaa spindle. The meter was recovered in good condition.


TEMPERATURE
IN DEG C
7
8
VELOCITY IN CM/SEC
SOUTH
NORTH
WEST
EAST
-50
0
50
-200
-150
-100
-50
0
50
100
150
200
20'TH MAR 77
27'TH MAR 77
3'RD APR 77
10'TH APR 77
17'TH APR 77


PER CENT
80
50
40
30
20
10
0
0
50
100
150
SPEED IN CM/SEC
0
90
180
270
360
DIRECTION


NORTH
SOUTH
WEST
EAST
200
150
100
50
0
-50
-100
-150
-200
-200
-150
-100
-50
0
50
100
150
200

EAST
NORTH
30
20
10
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
27'TH MAR 77
3'RD APR 77
10'TH APR 77
17'TH APR 77

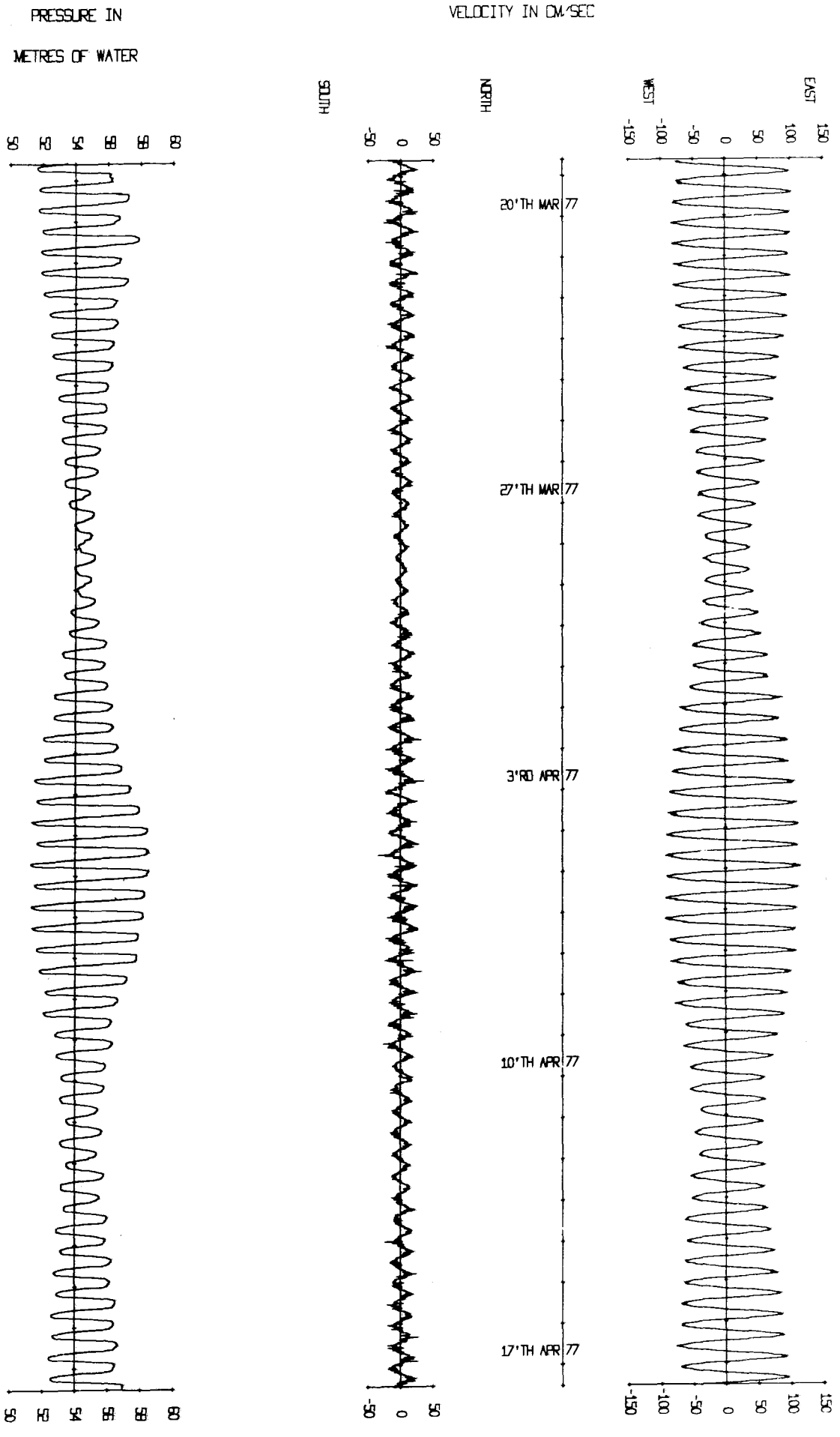
20'TH MAR 77
27'TH MAR 77
3'RD APR 77
10'TH APR 77
17'TH APR 77

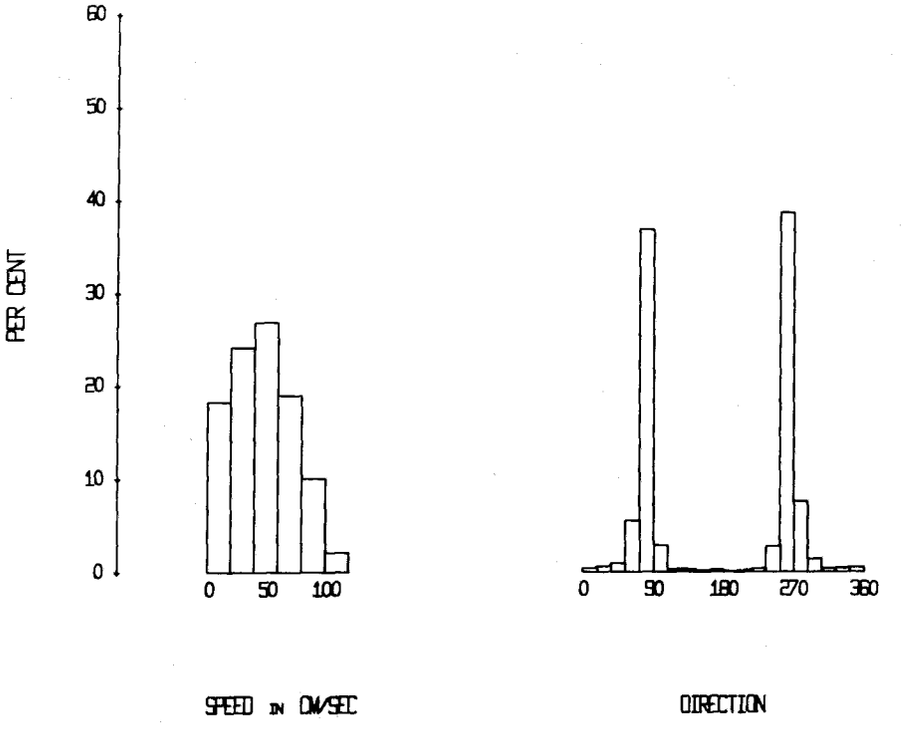
Meter	: Aanderaa 2574
Tape number	: 2574/1
Meter started	: 13.28.30 GMT 19 March 1977
Meter stopped	: -
Total number of readings	: 9645
Timing error	: -
Start of useful record	: 14.17 GMT 19 March 1977
End of useful record	: 21.50.30 GMT 22 March 1977
Length of useful record	: 79.5 h
Comments	: The meter was fitted with a 0-100 PSI pressure sensor, a 2-D liquid resistance tiltmeter and a 0.5 rev/count rotor counter. It was clamped to the wire 2m below the top meter on the rig and sampled every 30s. Its records are not displayed in the data report.

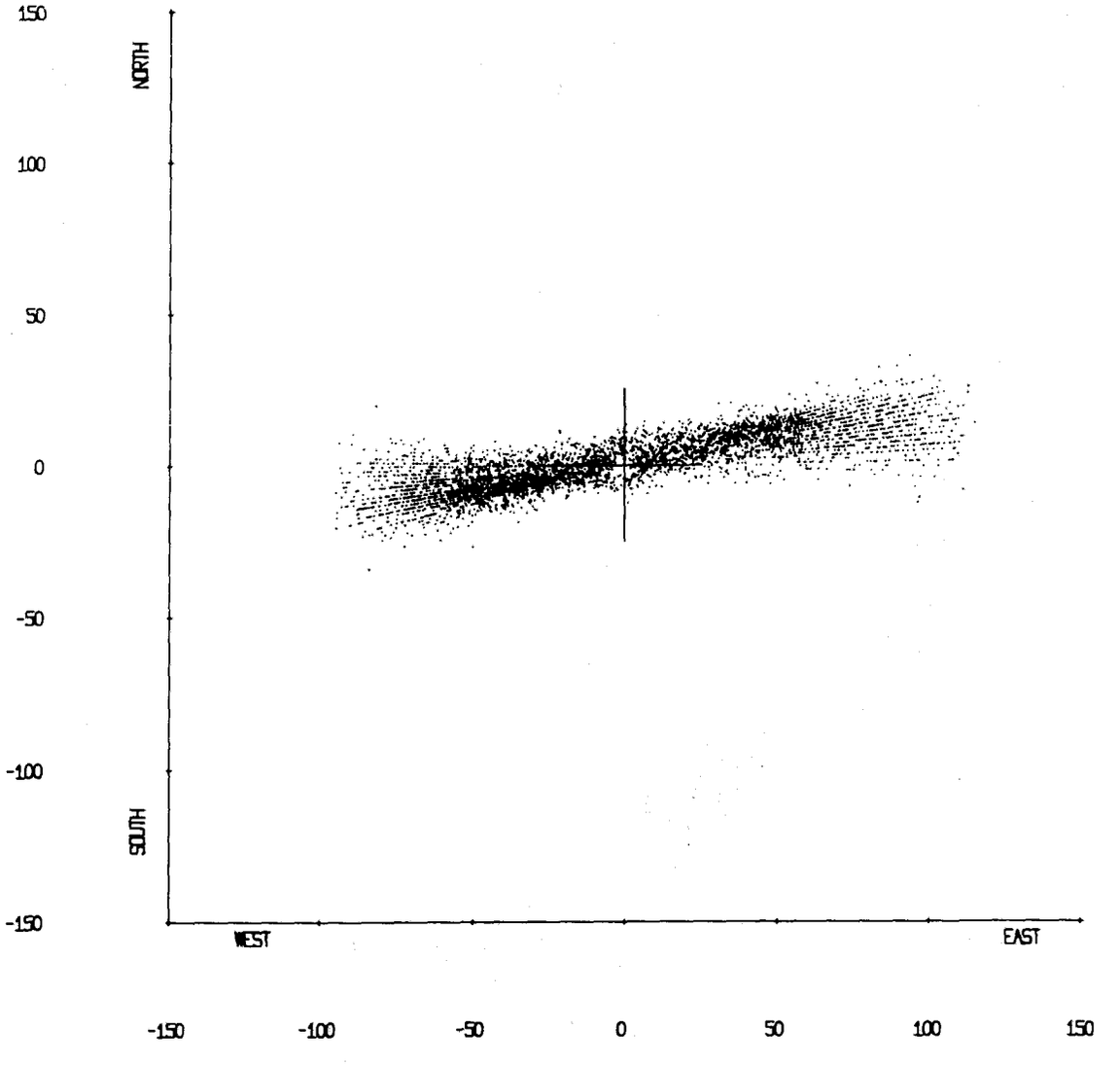
Meter	: Aanderaa 1139	
Tape number	: 1139/7	
Meter started	: 13.00.00 GMT	19 March 1977
Meter stopped	: 13.40.41 GMT	18 April 1977
Total number of readings	: 4325	
Timing error	: 41s slow	
Start of useful record	: 14.30 GMT	19 March 1977
End of useful record	: 12.21 GMT	18 April 1977
Length of useful record	: 717 h	

Comments : Good velocity and pressure record. The meter was fitted with a 0-100 PSI pressure sensor, a pendulum tiltmeter and a modified spindle. The temperature record has not been displayed because there were many encoder errors in it.

The meter was recovered in good condition but the spindle was slightly stiff.


PRESSURE IN
METRES OF WATER
VELOCITY IN CM/SEC
SOUTH
NORTH
WEST
EAST
20'TH MAR 77
27'TH MAR 77
3'RD APR 77
10'TH APR 77
17'TH APR 77


PER CENT
60
50
40
30
20
10
0
0
50
100
0
90
180
270
360
SPEED IN CM/SEC
DIRECTION


150
100
50
0
-50
-100
-150
NORTH
SOUTH
WEST
EAST
-150
-100
-50
0
50
100
150

WEST
-10
SOUTH
0
10
20
30
40
50
NORTH
EAST
20'TH MAR 77
27'TH MAR 77
3'RD APR 77
10'TH APR 77
17'TH APR 77

20'TH MAR 77
27'TH MAR 77
3'RD APR 77
10'TH APR 77
17'TH APR 77

Mooring number : 127

Position of rig : LAT 53°54.0'N LONG 4°24.6'W (RIG 16)

Depth of water : 56m below chart datum

Tidal heights, in metres above chart datum, at Hilbre Island	MHWS	MHWN	MLWN	MLWS
	8.6	6.7	2.5	0.8

Meter	Type	Height above sea floor (m)	Recording interval (min)
1750	Aanderaa RCM4	35	10
1506	Aanderaa RCM4	8	10

Rig set : 16.54 GMT 19 March 1977 from R.R.S. 'John Murray'

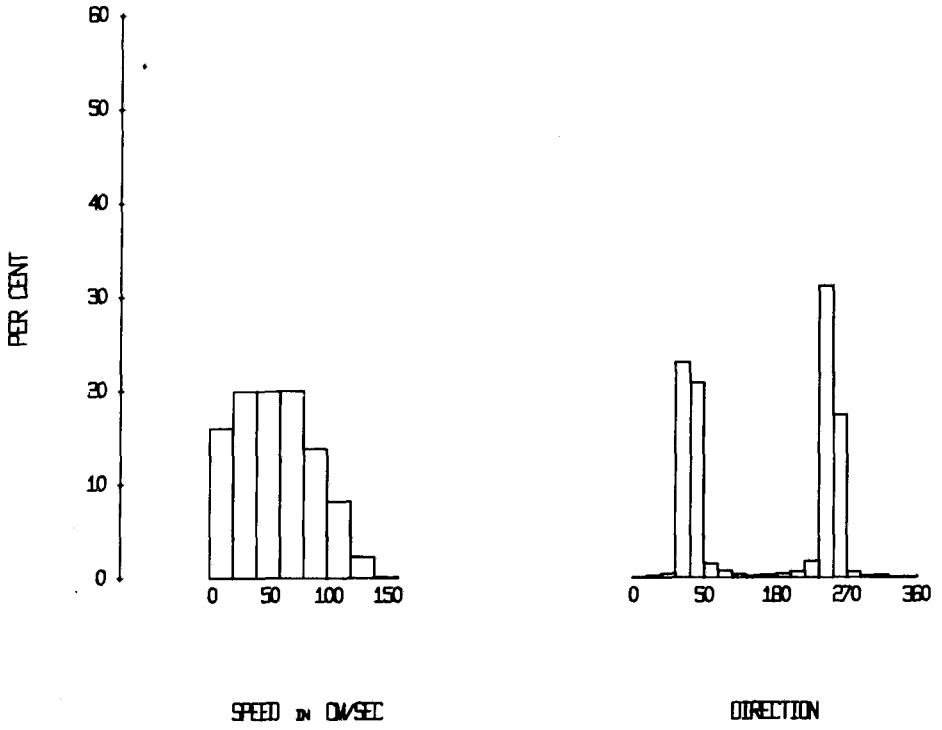
Rig recovered : 08.57 GMT 18 April 1977 from R.R.S. 'John Murray'

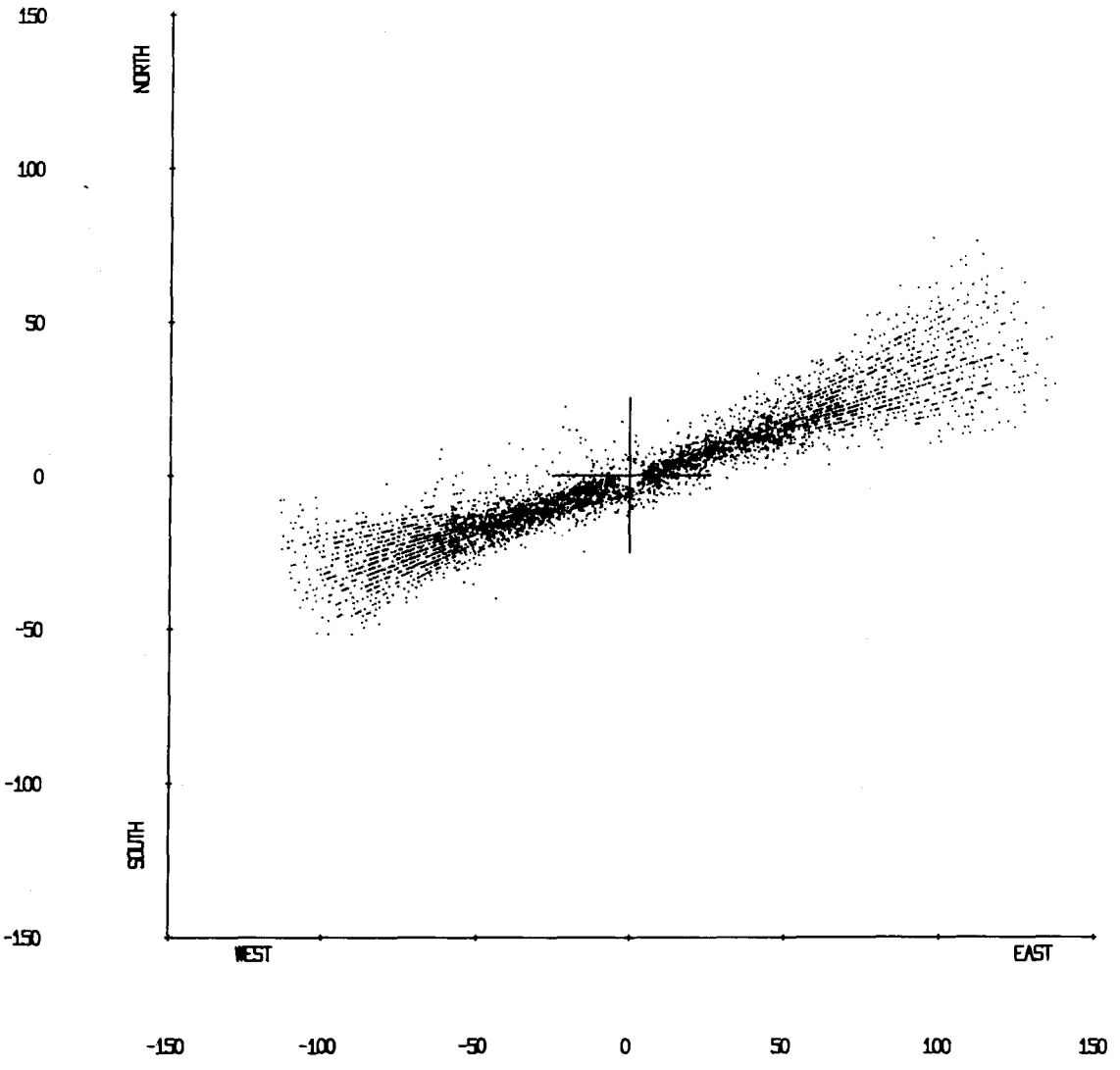
Mooring : Standard with pillar surface buoy.

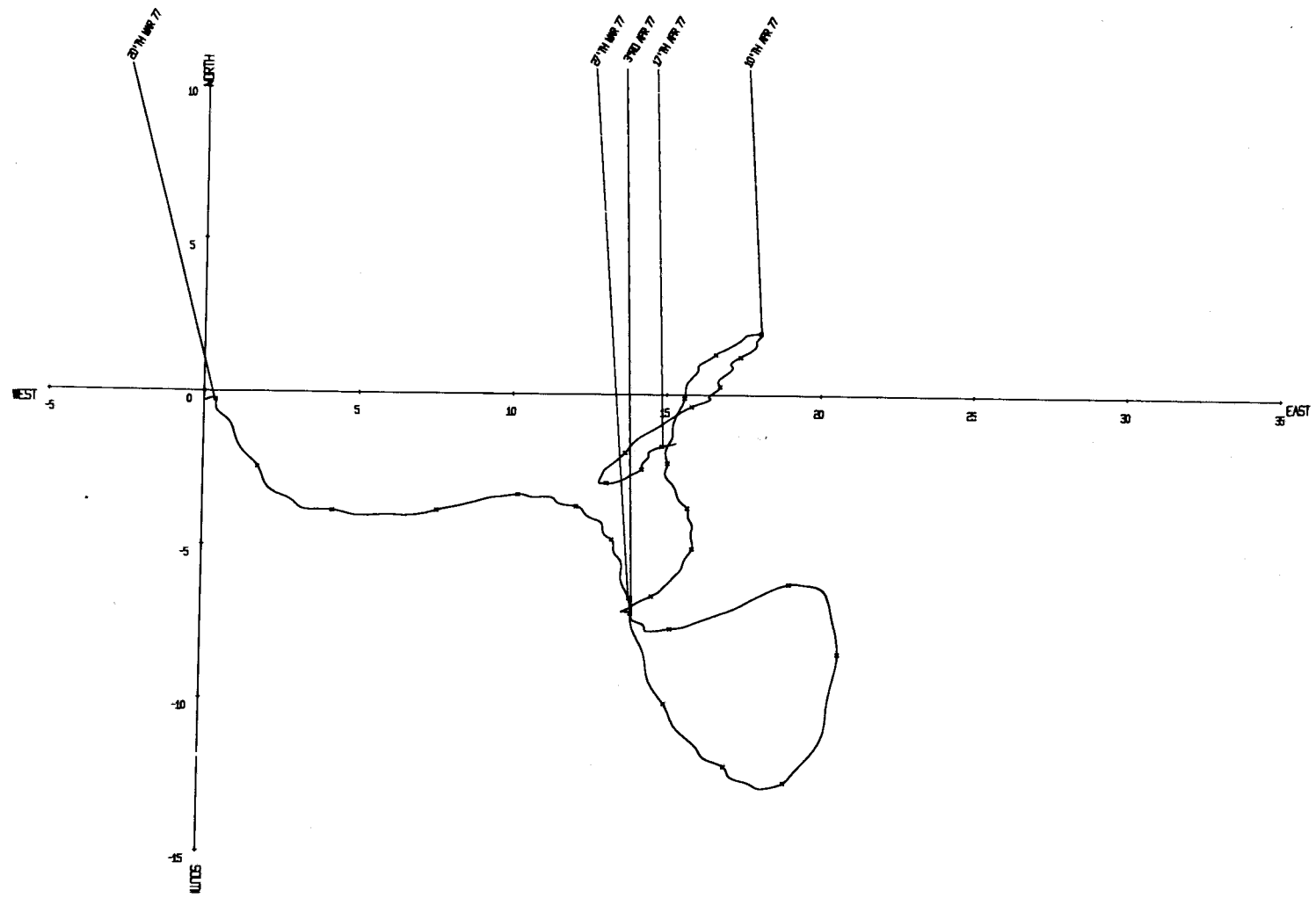
Comments : The rig was launched but the pellet floats above the sub-surface buoy were not visible. The recovery was successfully accomplished at the first attempt. However, the bottom meter was tangled with the ground line. The pressure record from the top meter shows a 3m difference between it and the water depth at launch recorded on the ship, consistent with the bottom meter being tangled with the ground line and so nearer the sea floor.

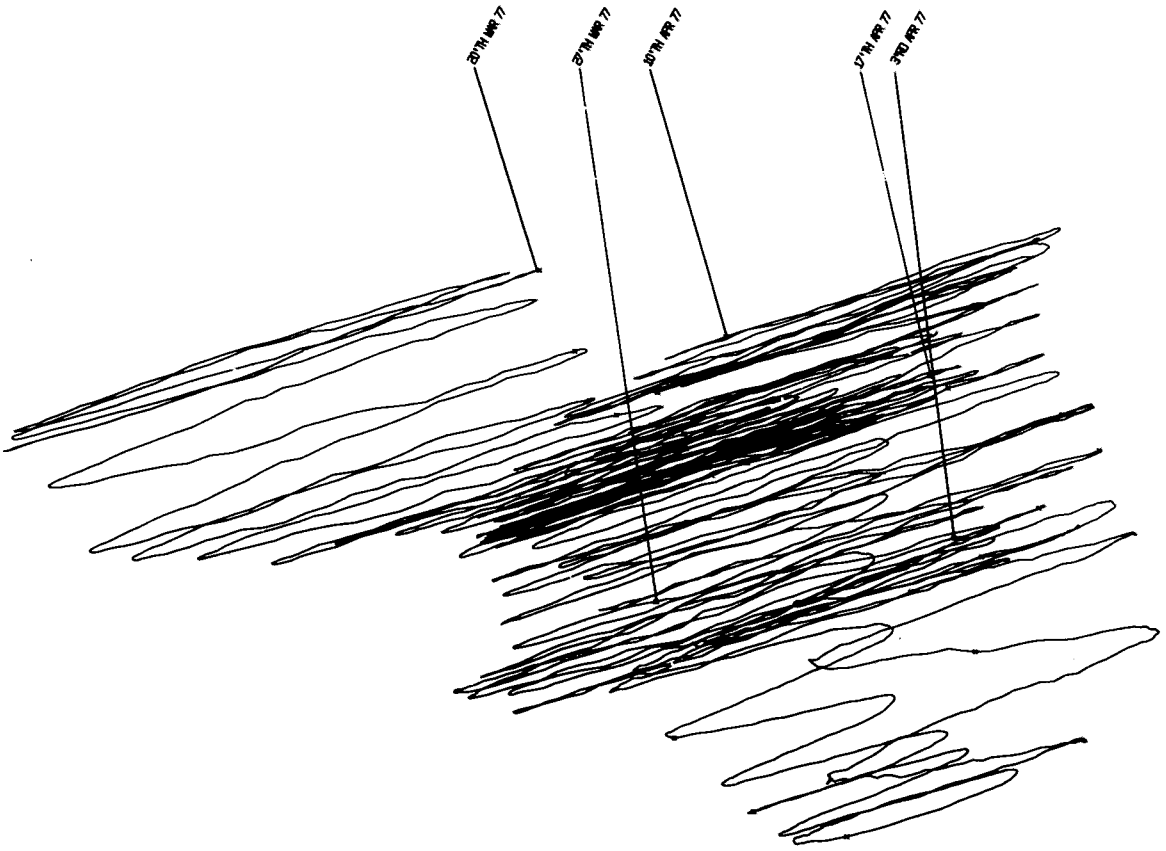
Meter	: Aanderaa 1750	
Tape number	: 1750/5	
Meter started	: 15.50.00 GMT	19 March 1977
Meter stopped	: 10.20.09 GMT	18 April 1977
Total number of readings	: 4288	
Timing error	: 9s slow	
Start of useful record	: 17.00 GMT	19 March 1977
End of useful record	: 08.30 GMT	18 April 1977
Length of useful record	: 711 h	
Comments	: Good record. The meter was fitted with a 0-200 PSI pressure sensor and a new Aanderaa spindle. It was recovered in good condition. There were very few errors in the record.	

TEMPERATURE
IN DEG C
PRESSURE IN
METRES OF WATER
VELOCITY IN CM/SEC
SOUTH
NORTH
WEST
EAST
-100
-50
0
50
100
-150
150
7
8
22
24
26
28
30
32
20'TH MAR 77
27'TH MAR 77
3'RD APR 77
10'TH APR 77
17'TH APR 77

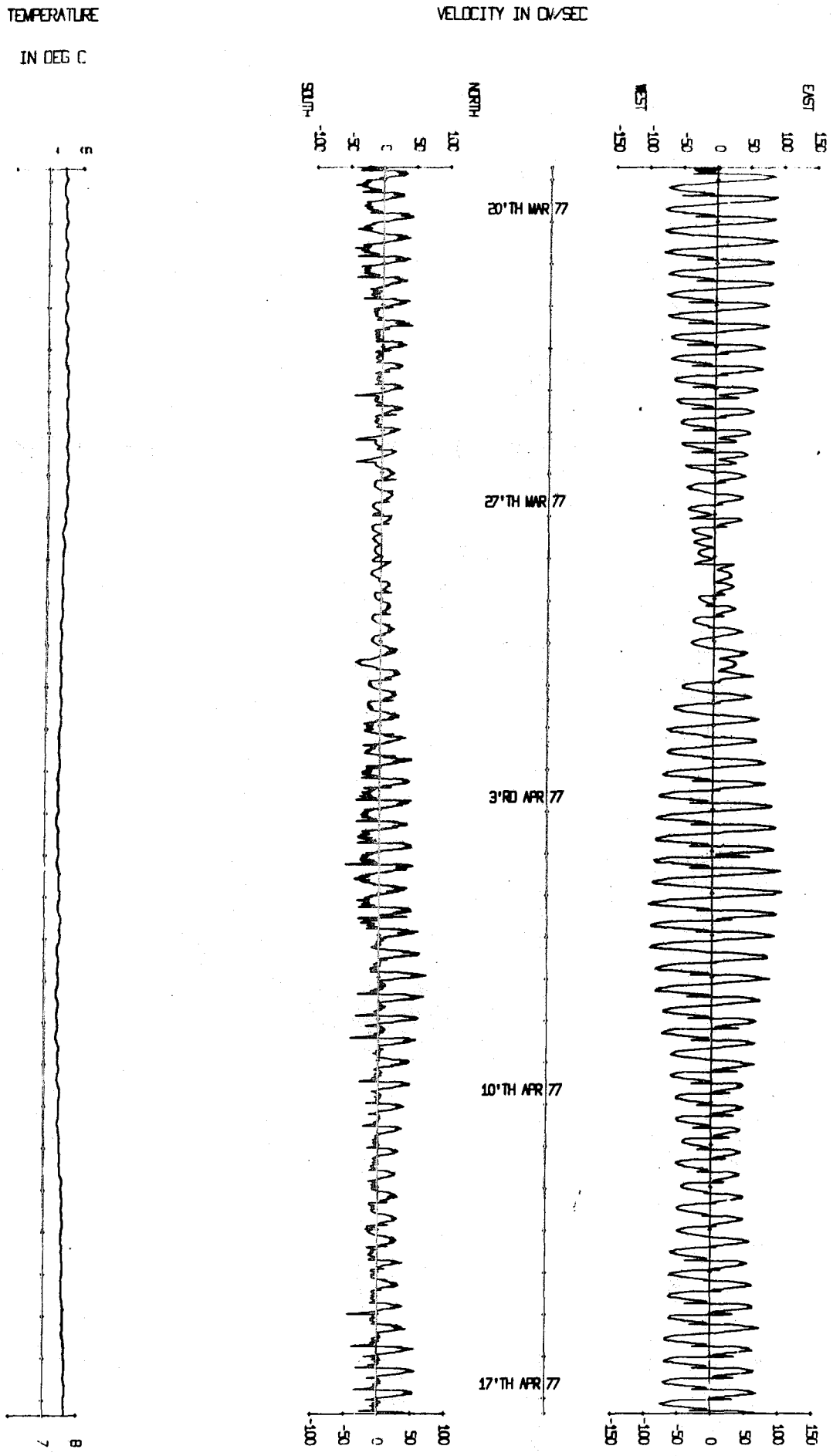

PER CENT
60
50
40
30
20
10
0
0
50
100
150
SPEED IN CM/SEC
0
50
180
270
360
DIRECTION

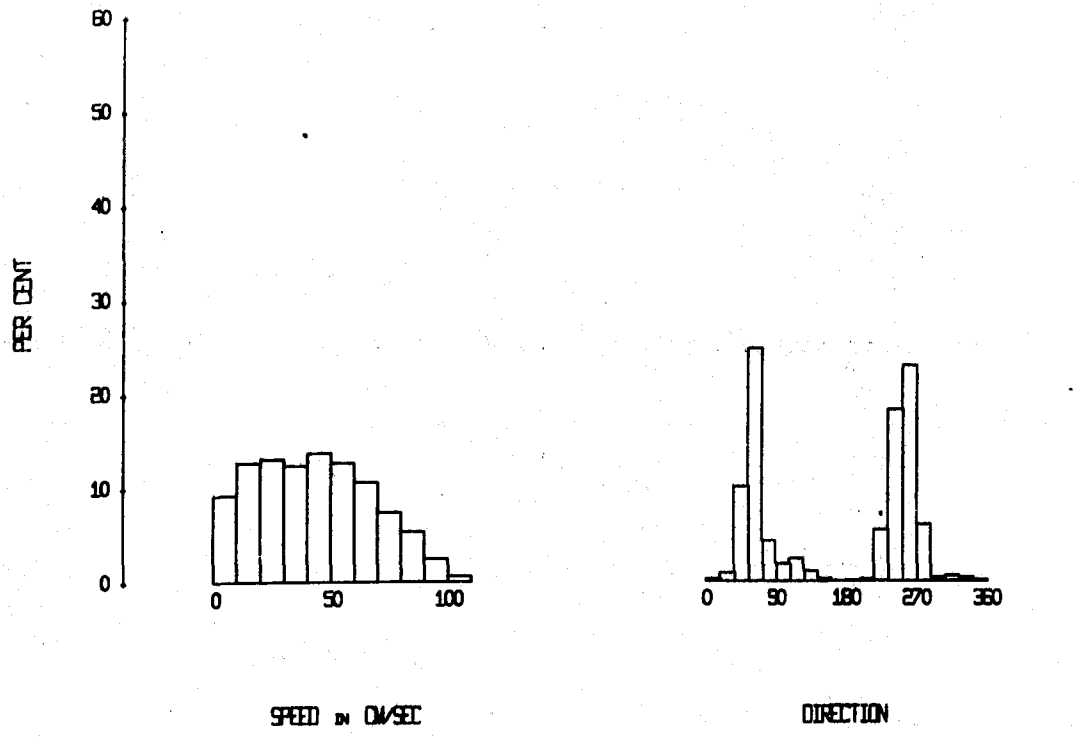

NORTH
SOUTH
WEST
EAST
150
100
50
0
-50
-100
-150
-150
-100
-50
0
50
100
150

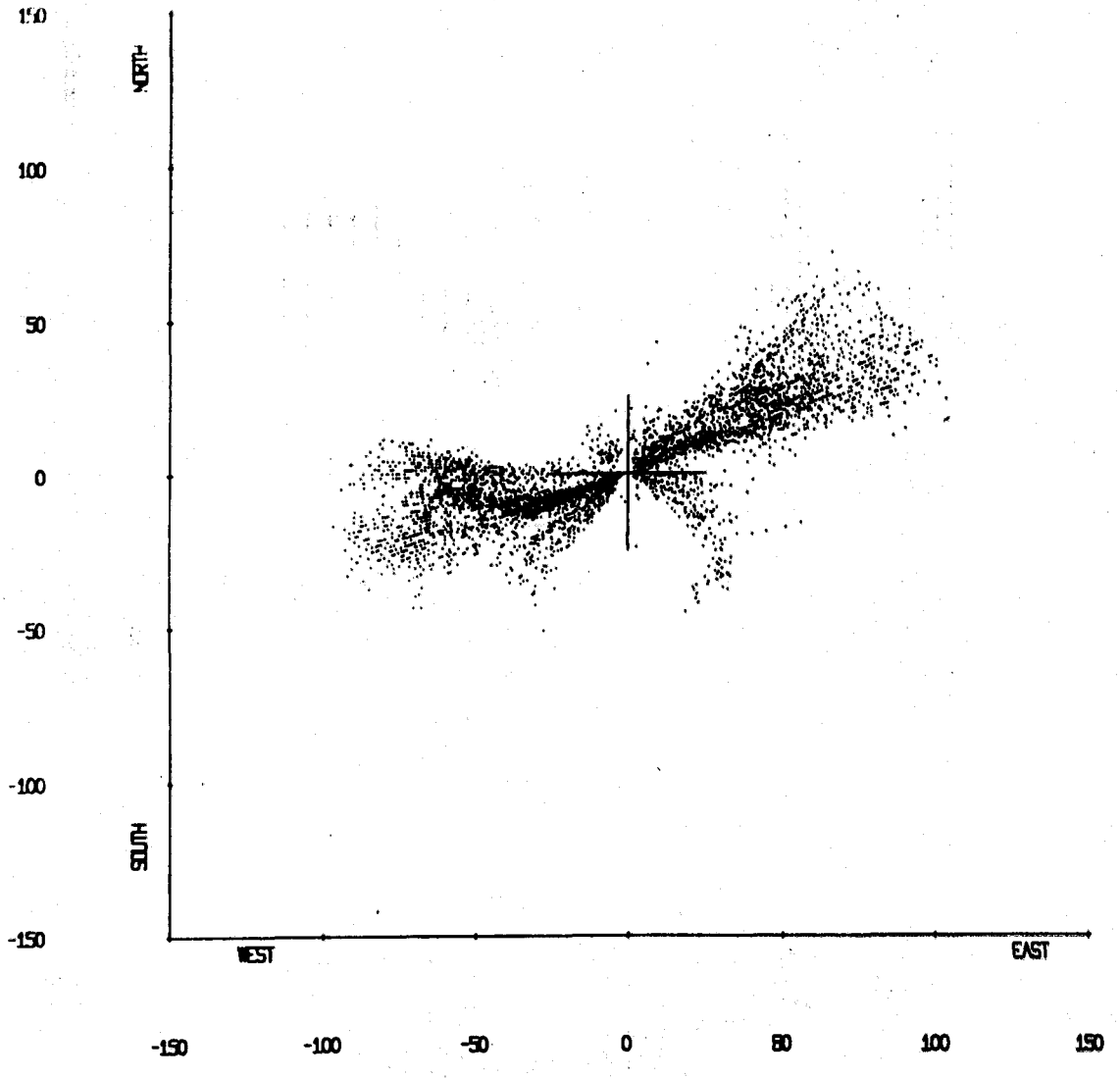

20TH MAR.77
27TH MAR.77
3RD APR.77
17TH APR.77
10TH APR.77
NORTH
SOUTH
WEST
EAST
10
5
0
-5
-10
-15
5
10
15
20
25
30
35

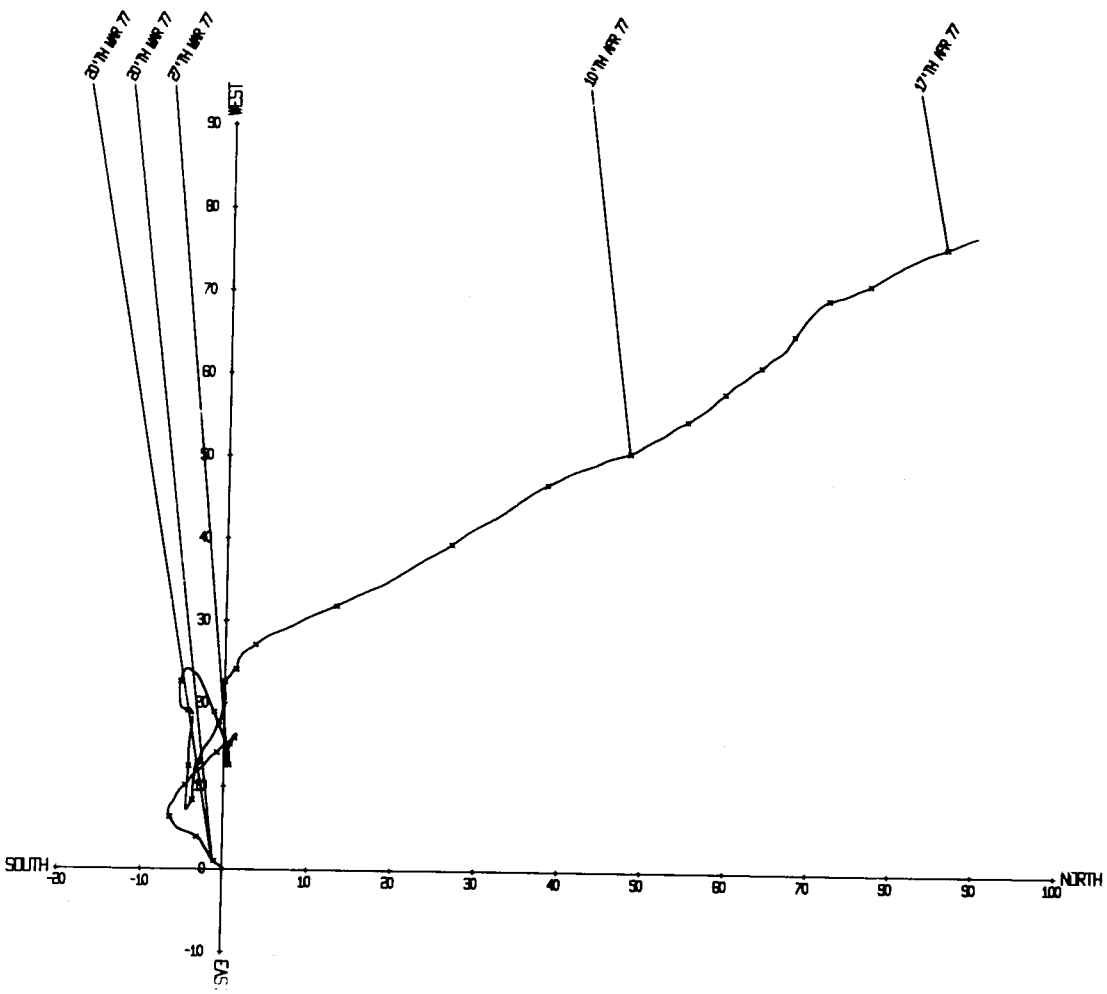

20TH MAR.77
27TH MAR.77
10TH APR.77
17TH APR.77
3RD APR.77

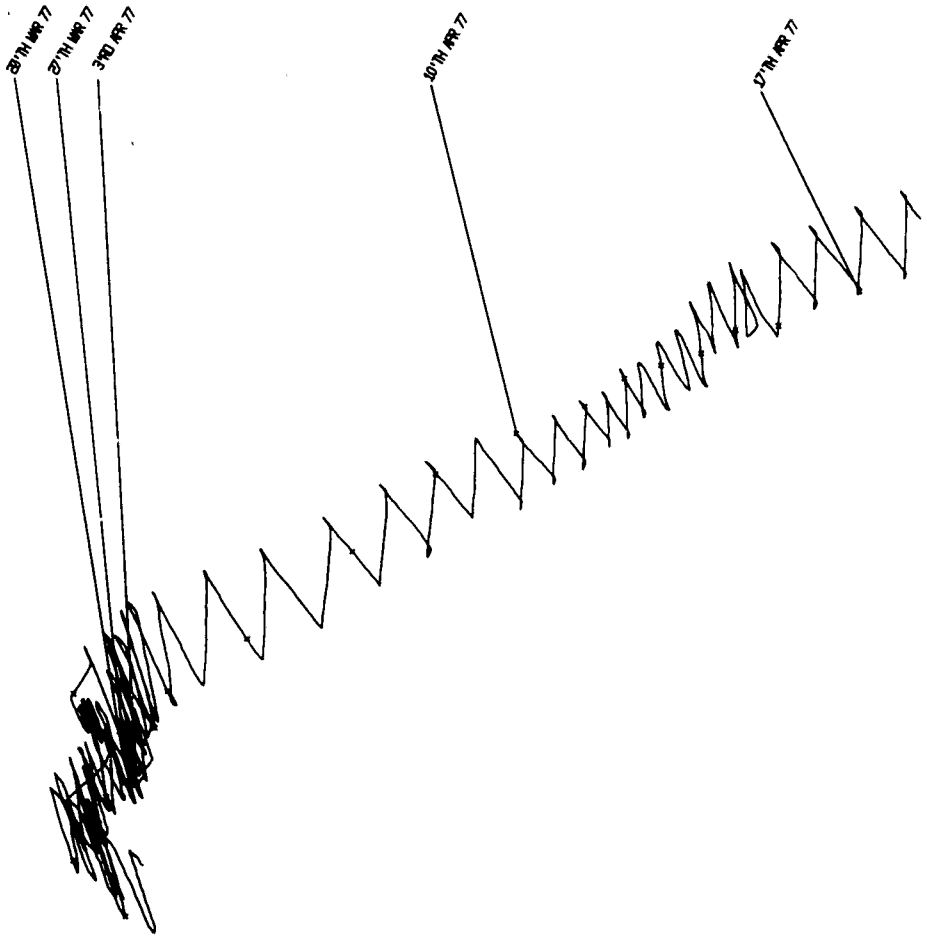
Meter	:	Aanderaa 1506
Tape number	:	1506/2
Meter started	:	15.50.00 GMT 19 March 1977
Meter stopped	:	10.29.49 GMT 18 April 1977
Total number of readings	:	4289
Timing error	:	11 s fast
Start of useful record	:	-
End of useful record	:	-
Length of useful record	:	-
Comments	:	The meter was fitted with a modified spindle. The meter was recovered tangled with the ground line and with its spindle bent. The plots show that this happened during the launch. The temperature record is good and goes from 17.00 19 March to 08.30 18 April.


TEMPERATURE
IN DEG C
VELOCITY IN CM/SEC
SOUTH
NORTH
WEST
EAST
20'TH MAR 77
27'TH MAR 77
3'RD APR 77
10'TH APR 77
17'TH APR 77


PER CENT
60
50
40
30
20
10
0
0
50
100
SPEED IN CM/SEC
0
90
180
270
360
DIRECTION


NORTH
150
100
50
0
-50
-100
-150
SOUTH
WEST
EAST
-150
-100
-50
0
50
100
150


20'TH MAR 77
20'TH MAR 77
27'TH MAR 77
10'TH APR 77
17'TH APR 77
WEST
EAST
SOUTH
NORTH
-20
-10
0
10
20
30
40
50
60
70
80
90
100


20'TH MAR 77
27'TH MAR 77
3'RD APR 77
10'TH APR 77
17'TH APR 77

Mooring number : 128

Position of rig : LAT 53°24.0'N LONG 3°55.5'W (RIG 2)

Depth of water : 22m below chart datum

Tidal heights, in metres above chart datum, at Hilbre Island :

MHWS	MHWN	MLWN	MLWS
8.6	6.7	2.5	0.8

Meter	Type	Height above sea floor (m)	Recording interval (min)
1749	Aanderaa RCM4	11	10

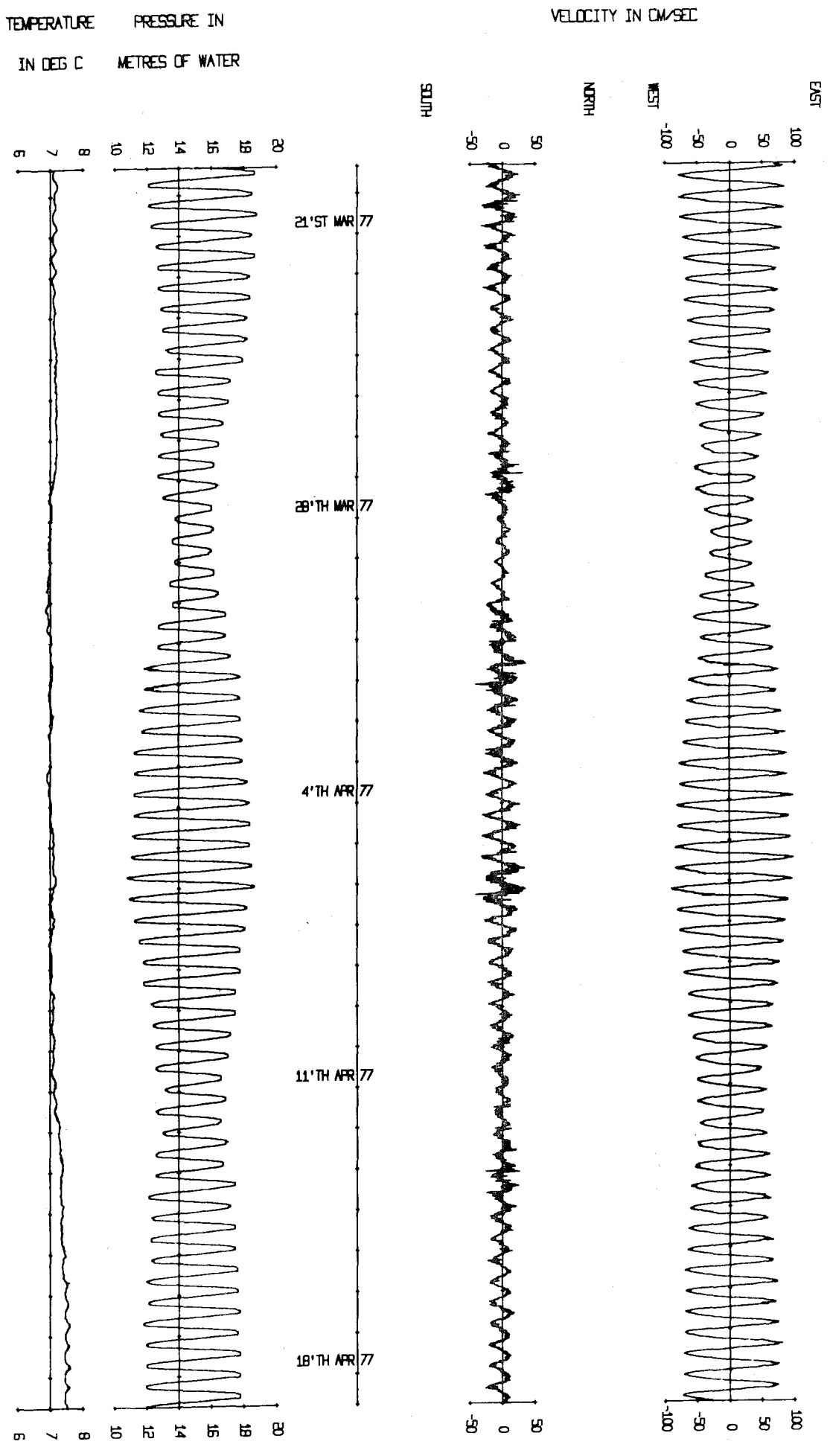
Rig set : 07.37 GMT 20 March 1977 from R.R.S. 'John Murray'

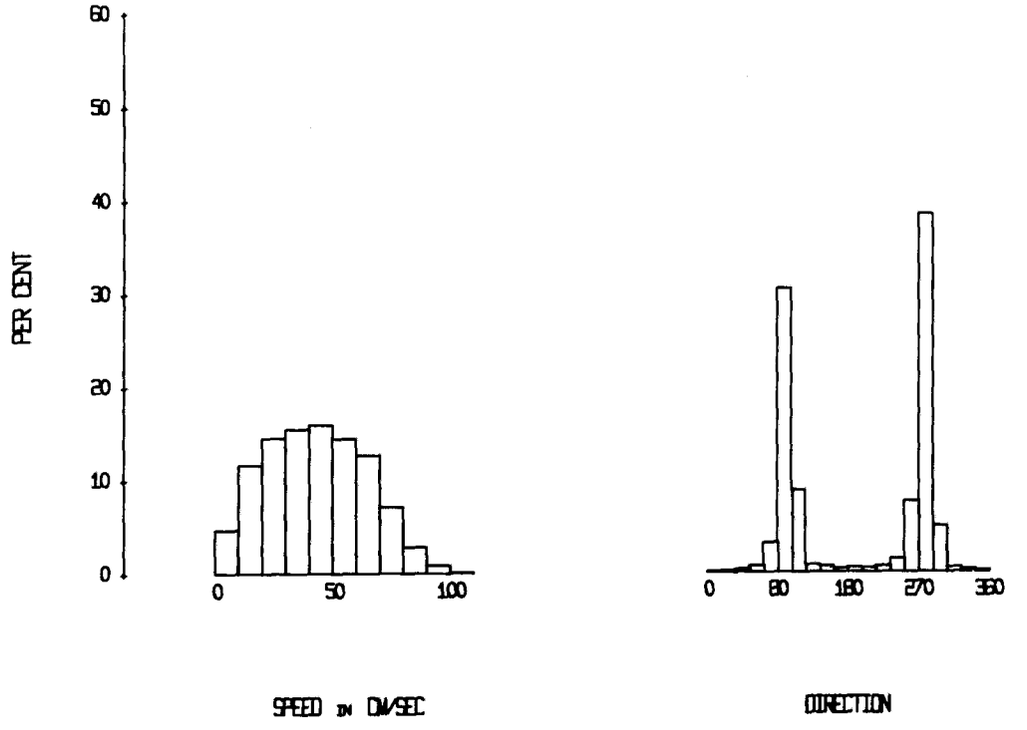
Rig recovered : 18.12 GMT 19 April 1977 from R.R.S. 'John Murray'

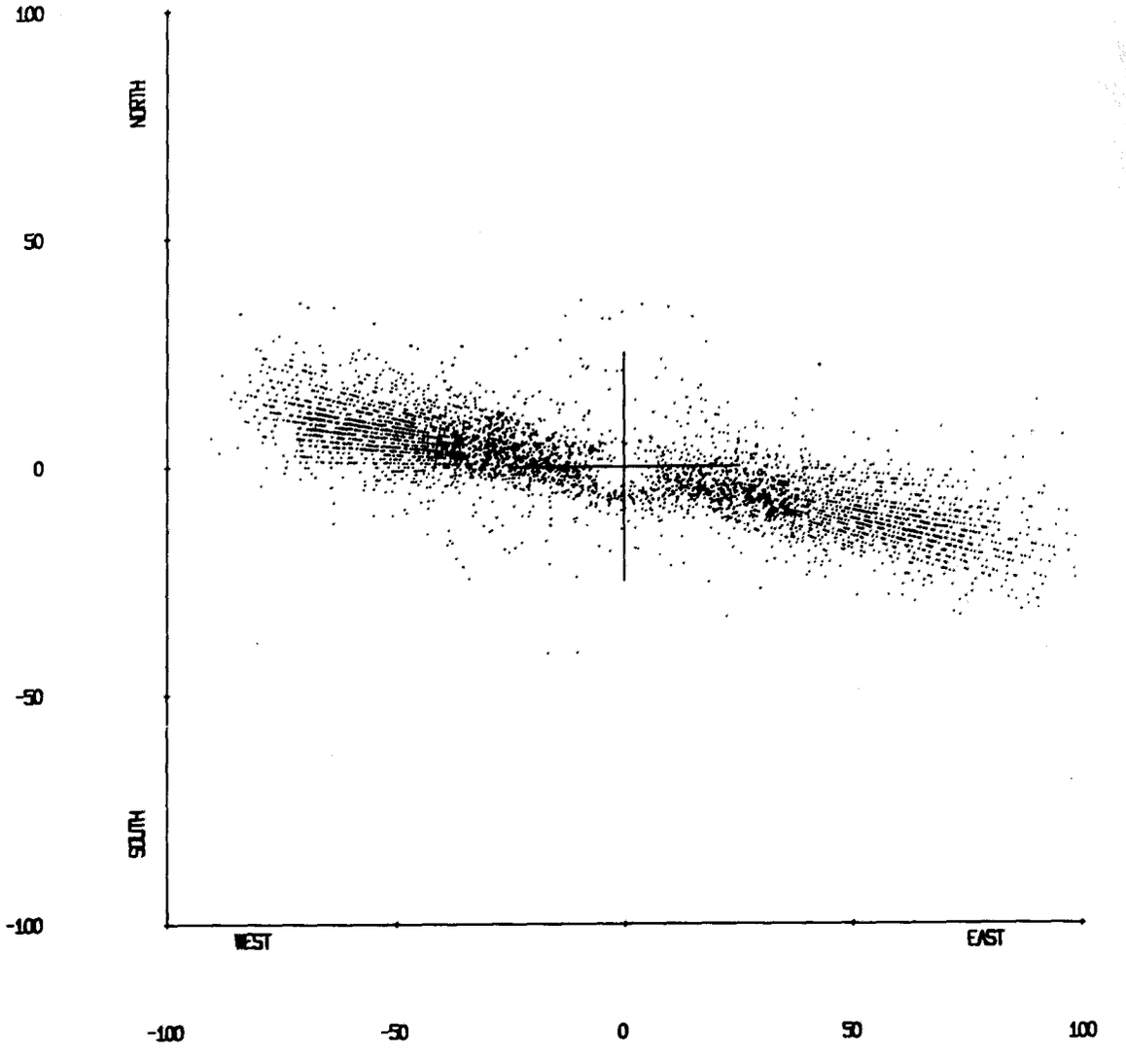
Mooring : Standard

Comments : The rig was successfully launched at the first attempt. When it was checked on 25 March the toroid was upside down and was righted. On arrival for recovery the toroid was again upside down, but the recovery was accomplished at the first attempt.

Meter	: Aanderaa 1749
Tape number	: 1749/4
Meter started	: 06.00.00 GMT 20 March 1977
Meter stopped	: 18.49.17 GMT 19 April 1977
Total number of readings	: 4398
Timing error	: 43s fast
Start of useful record	: 07.40 GMT 20 March 1977
End of useful record	: 17.49 GMT 19 April 1977
Length of useful record	: 730 h
Comments	: Good record. The meter was fitted with a 0-200 PSI pressure sensor and an Aanderaa spindle. When it was recovered the tail 1/3 of the vane was missing and its spindle bearing had collapsed. There is no indication of this in the plots. There were no errors in the record.


TEMPERATURE
IN DEG C
PRESSURE IN
METRES OF WATER
VELOCITY IN CM/SEC
SOUTH
NORTH
WEST
EAST
21'ST MAR 77
28'TH MAR 77
4'TH APR 77
11'TH APR 77
18'TH APR 77


PER CENT
60
50
40
30
20
10
0
0
50
100
0
90
180
270
360
SPEED IN CM/SEC
DIRECTION


100
50
0
-50
-100
NORTH
SOUTH
WEST
EAST
-100
-50
0
50
100

17TH APR 77
10TH APR 77
3RD APR 77
27TH MAR 77
20TH MAR 77

WEST
80
70
60
50
40
30
20
10
0
10
20
30
SOUTH
NORTH
EAST
18TH APR 77
11TH APR 77
4TH APR 77
28TH MAR 77
21ST MAR 77

Mooring number : 129

Position of rig : LAT. 53°53.6' LONG. 3°30.3'W (RIG 13)

Depth of water : 21m below chart datum

Tidal heights, in metres above chart datum, at Hilbre Island :

MHWS	MHWN	MLWN	MLWS
8.6	6.7	2.5	0.8

Meter	Type	Height above sea floor (m)	Recording interval (min)
2575	Aanderaa RCM4	8	10

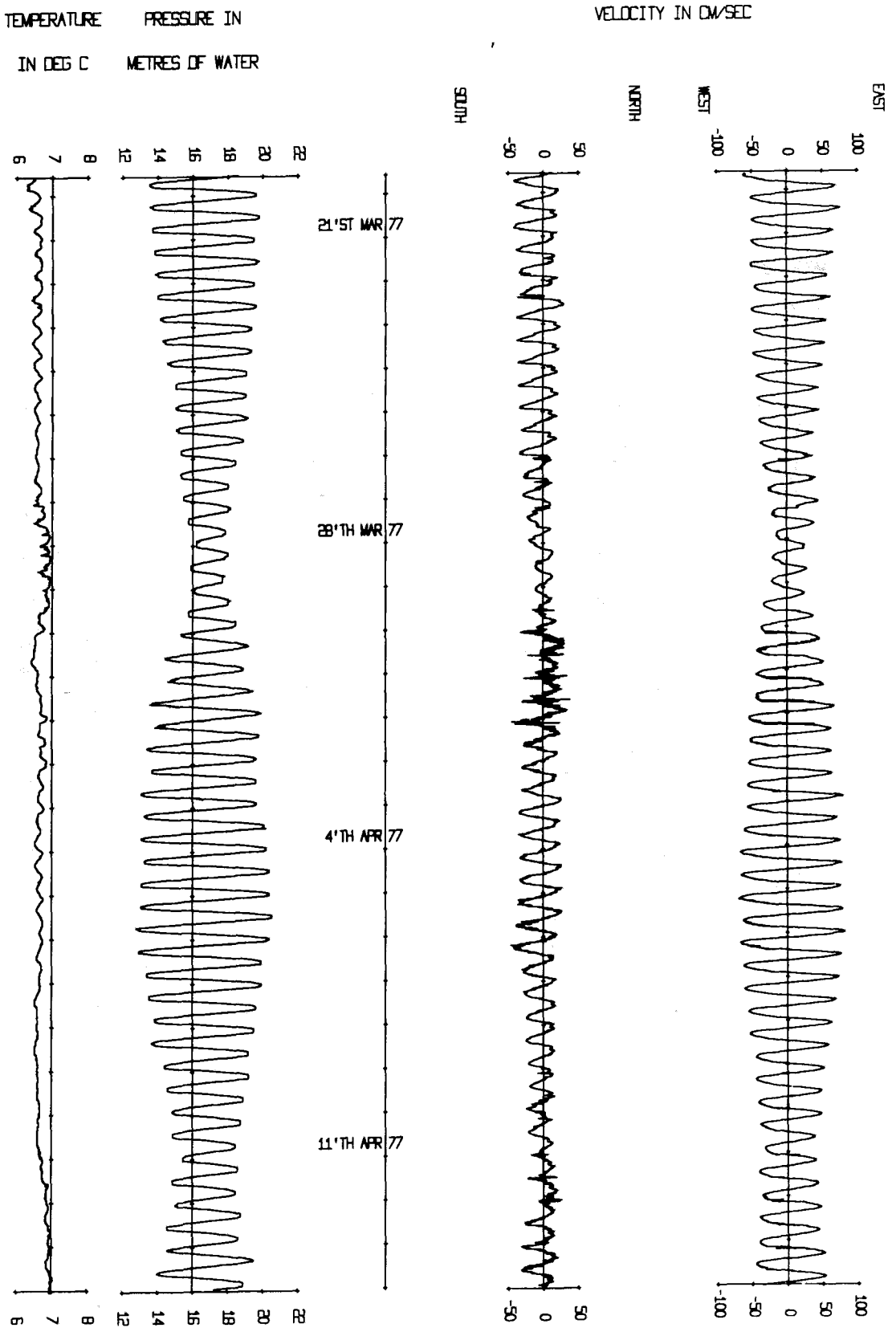
Rig set : 13.29 GMT 20 March 1977 from R.R.S. 'John Murray'

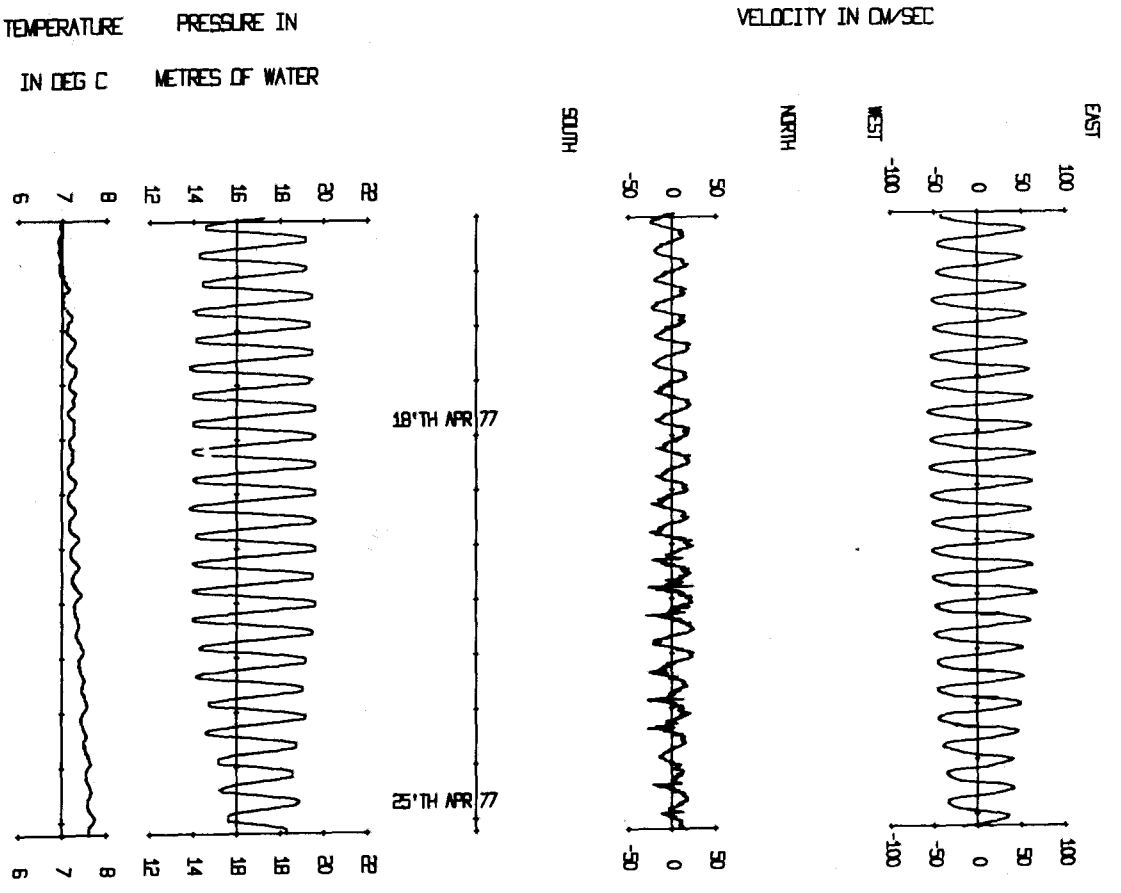
Rig recovered : 05.30 GMT 26 April 1977 from R.R.S. 'John Murray'

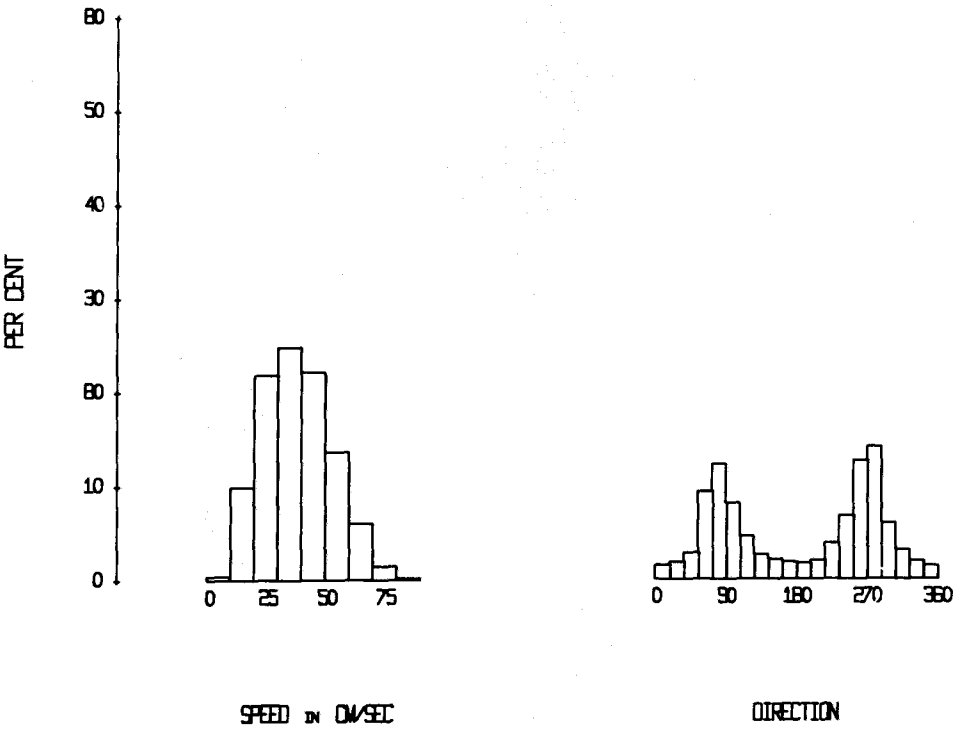
Mooring : Standard

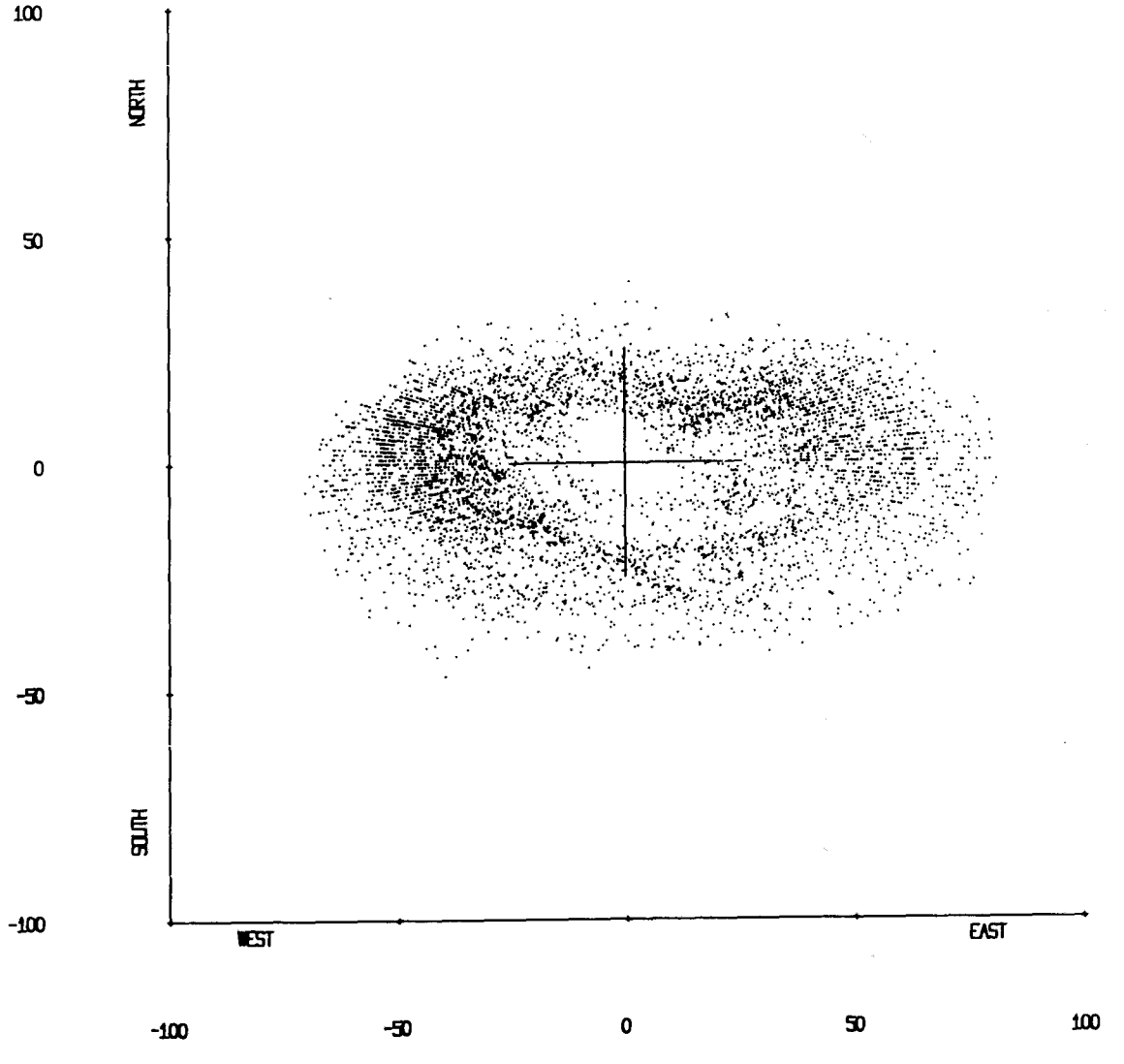
Comments : The launch and recovery were successfully accomplished at the first attempt although the toroid was upside down when the recovery was started. On recovery the sub-surface buoy pellet line was tangled with the meter wire but not the current meter. The sub-surface buoy had been dented in two places before recovery.

Meter	: Aanderaa 2575	
Tape number	: 2575/1	
Meter started	: 12.00.00 GMT	20 March 1977
Meter stopped	: 08.30.05 GMT	26 April 1977
Total number of readings	: 5308	
Timing error	: 5s slow	
Start of useful record	: 13.30 GMT	20 March 1977
End of useful record	: 05.10 GMT	26 April 1977
Length of useful record	: 879 h	
Comments	: Good record, very few errors. The meter was fitted with a 0-200 PSI pressure sensor and a new Aanderaa spindle. It was recovered in good condition.	


TEMPERATURE
IN DEG C
PRESSURE IN
METRES OF WATER
VELOCITY IN CM/SEC
21'ST MAR 77
28'TH MAR 77
4'TH APR 77
11'TH APR 77
SOUTH
NORTH
WEST
EAST


TEMPERATURE
IN DEG C
PRESSURE IN
METRES OF WATER
VELOCITY IN CM/SEC
6
7
8
12
14
16
18
20
22
18'TH APR 77
25'TH APR 77
SOUTH
NORTH
WEST
EAST
-50
0
50
-100
100


PER CENT
60
50
40
30
20
10
0
0
25
50
75
SPEED IN CM/SEC
0
90
180
270
360
DIRECTION


100
50
0
-50
-100
NORTH
SOUTH
WEST
EAST
-100
-50
0
50
100

WEST
EAST
SOUTH
NORTH
25'TH MAR 77
18'TH MAR 77
11'TH MAR 77
28'TH MAR 77
4'TH MAR 77
21'ST MAR 77

Mooring number : 130

Position of rig : LAT 54°1.3'N LONG 3°55.3'W (RIG 15)

Depth of water : 31m below chart datum

Tidal heights, in metres above chart datum, at Hilbre Island :	MHWS	MHWN	MLWN	MLWS
	8.6	6.7	2.5	0.8

Meter	Type	Height above sea floor (m)	Recording interval (min)
1508	Aanderaa RCM4	24	10
1865	Aanderaa RCM4	8	10

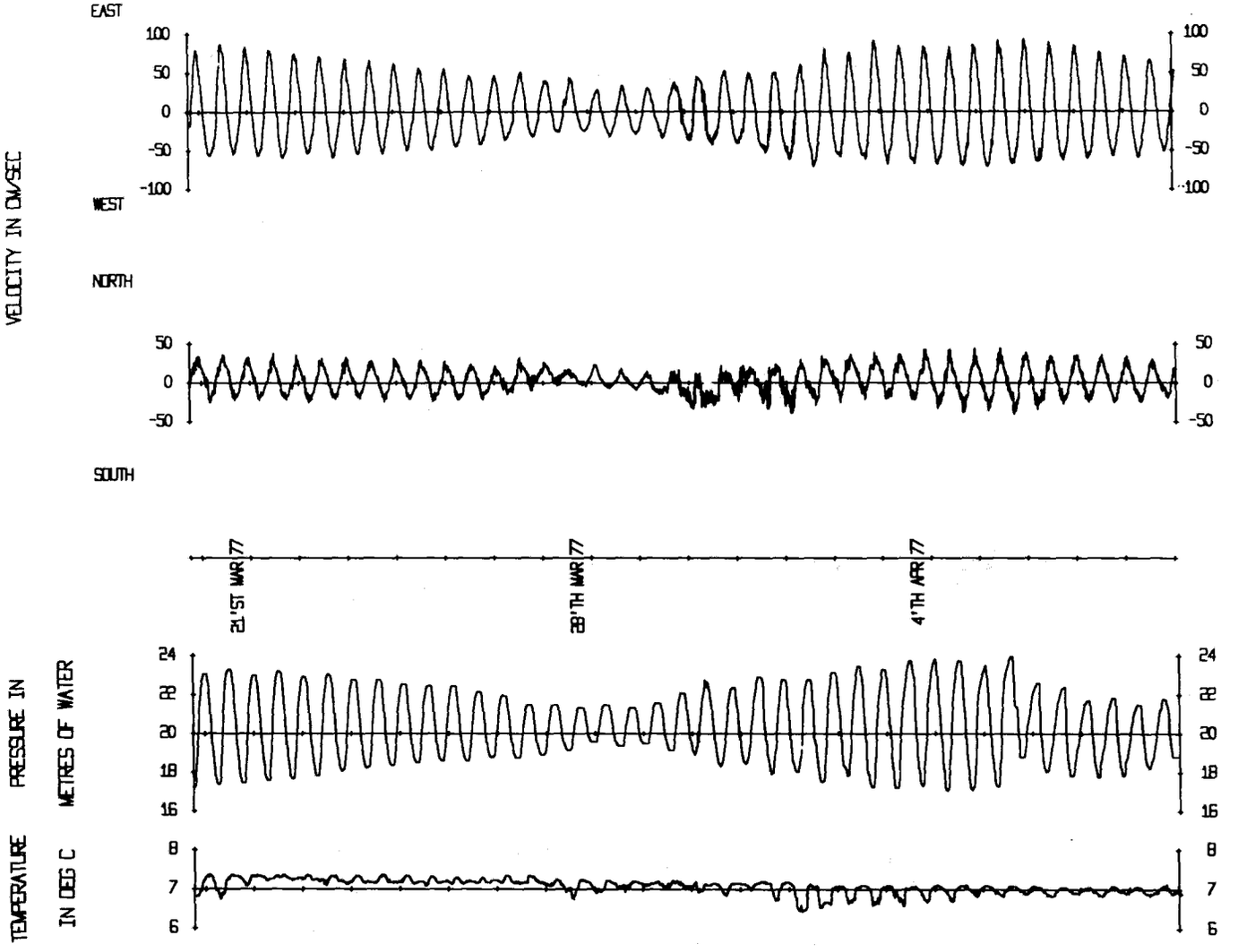
Rig set : 17.55 GMT 20 March 1977 from R.R.S. 'John Murray'

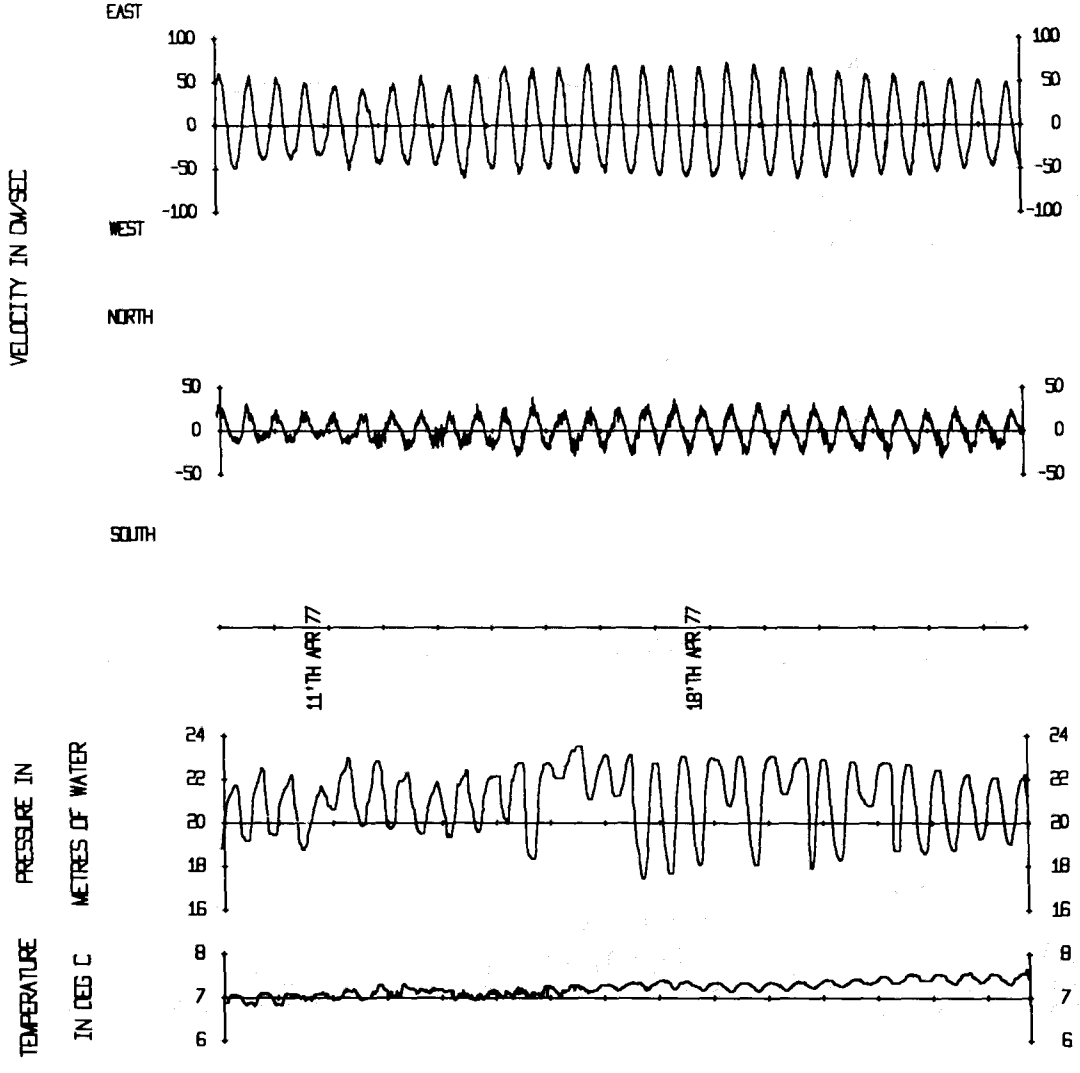
Rig recovered : 18.20 GMT. 24 April 1977 from R.R.S. 'John Murray'

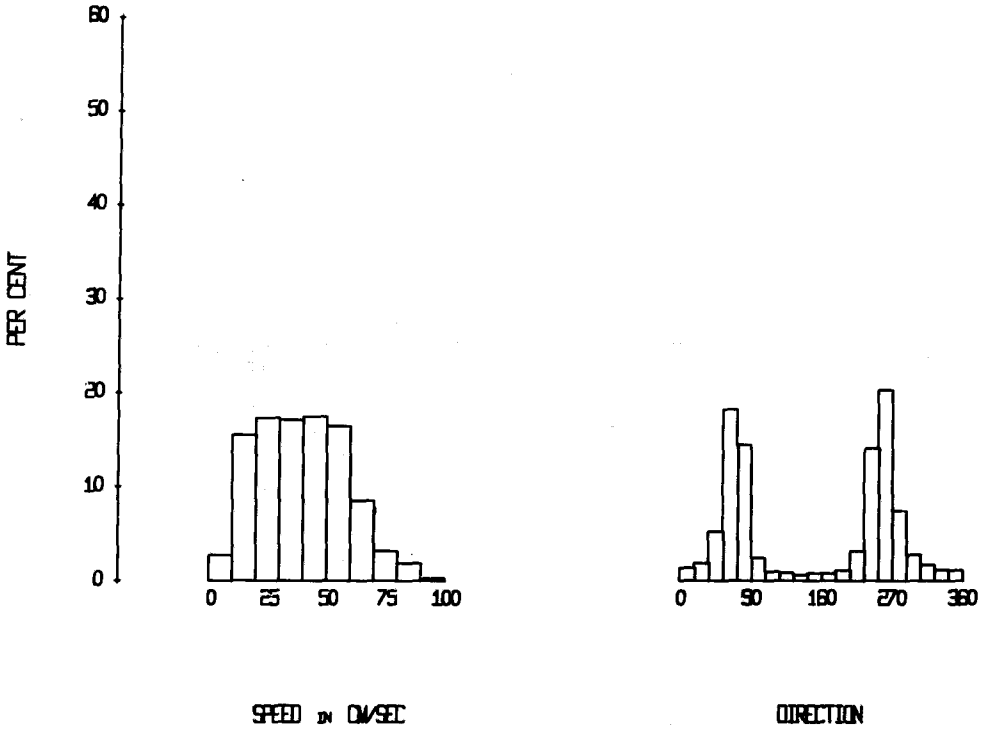
Mooring : Standard

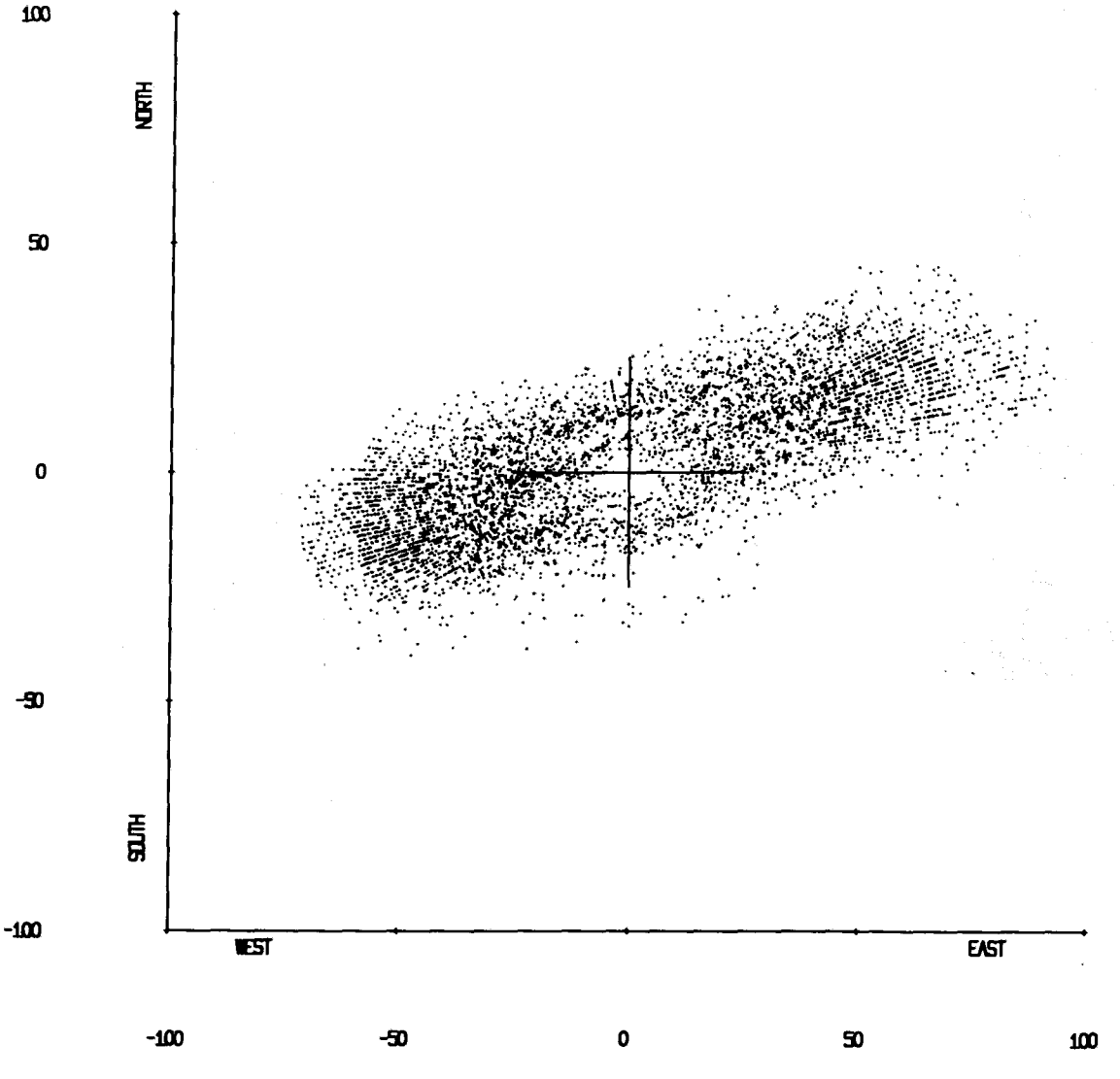
Comments : The launch was successfully accomplished at the first attempt. When the recovery was started the toroid was missing but the pellets marking the sub-surface buoy were visible in position. After several straight passes with a grapnel, the ship circled the pellet floats and when the wire was pulled in the rig was recovered. The surface buoy anchor weight was missing, although the ground line was not damaged and was intact. The toroid was later landed at Port Penrhyn by the fishing vessel 'Jacob Johannes'.

Meter	: Aanderaa 1508	
Tape number	: 1508/4	
Meter started	: 17.00.00	20 March 1977
Meter stopped	: 20.00.31	24 April 1977
Total number of readings	: 5059	
Timing error	: 31s slow	
Start of useful record	: 18.00 GMT	20 March 1977
End of useful record	: 18.01 GMT	24 April 1977
Length of useful record	: 840	
Comments	: Good record, very few errors. The meter was fitted with a 0-100 PSI pressure sensor and a new Aanderaa spindle. The meter was recovered in good condition. The pressure record is not reliable, especially from 6 April onwards.	


EAST
WEST
NORTH
SOUTH
VELOCITY IN CM/SEC
100
50
0
-50
-100
21'ST MAR 77
28'TH MAR 77
4'TH APR 77
TEMPERATURE IN DEG C
PRESSURE IN METRES OF WATER
24
22
20
18
16
8
7
6


EAST
100
50
0
-50
-100
WEST
VELOCITY IN CM/SEC
NORTH
50
0
-50
SOUTH
11'TH APR 77
18'TH APR 77
24
22
20
18
16
PRESSURE IN
METRES OF WATER
8
7
6
TEMPERATURE
IN DEG C


PER CENT
60
50
40
30
20
10
0
0
25
50
75
100
SPEED IN CM/SEC
0
90
180
270
360
DIRECTION


100
50
0
-50
-100
NORTH
SOUTH
WEST
EAST
-100
-50
0
50
100

21 ST MAR 77
28TH MAR 77
4TH APR 77
11TH APR 77
18TH APR 77
WEST
EAST
SOUTH
NORTH
-10
0
10
20
30
40
50
60
70
80
90
20
10
-10
-20

21 ST MAR 77
28TH MAR 77
4TH APR 77
11TH APR 77
18TH APR 77

Meter	: Aanderaa 1865	
Tape number	: 1865/1	
Meter started	: 17.00.01 GMT	20 March
Meter stopped	: -	
Total number of readings	: 4451	
Timing error	: -	
Start of useful record	: 18.00 GMT	20 March 1977
End of useful record	: 21.20 GMT	19 April 1977
Length of useful record	: 723 h	
Comments	: Good record until prematurely ended by a flat battery. The meter was fitted with an Aanderaa spindle and recorded elapsed time on channel 3. The latter was experimental and took more current than expected, hence the flat battery.	

TEMPERATURE

IN DEG C

6 7 8

8 7 6

VELOCITY IN CM/SEC

SOUTH

-50 0 50

50 0 -50

NORTH

21'ST MAR 77

28'TH MAR 77

4'TH APR 77

11'TH APR 77

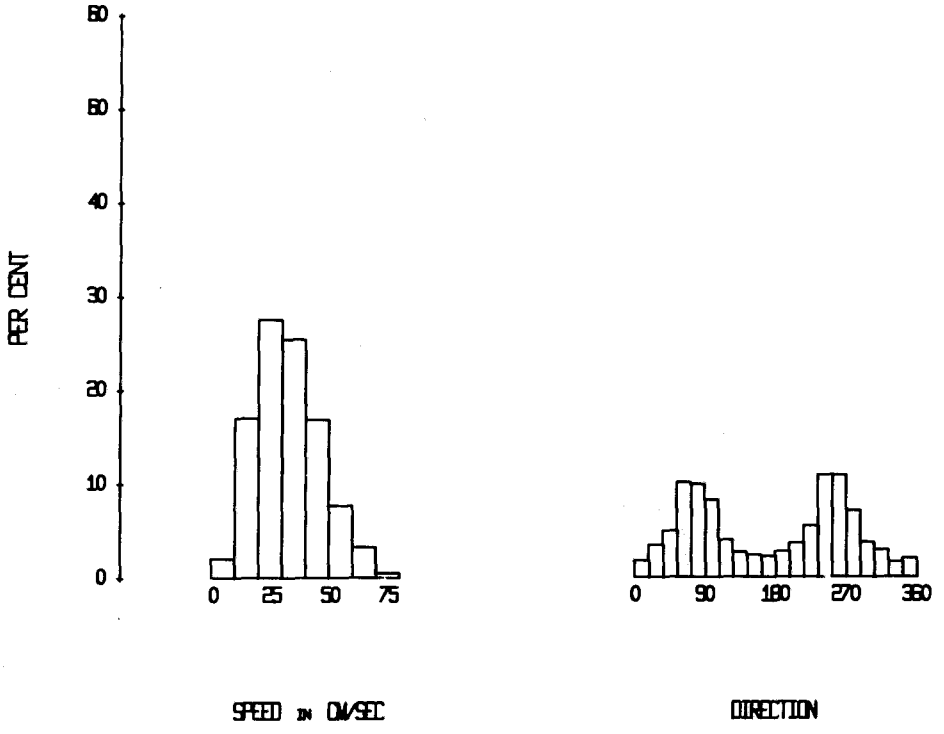
18'TH APR 77

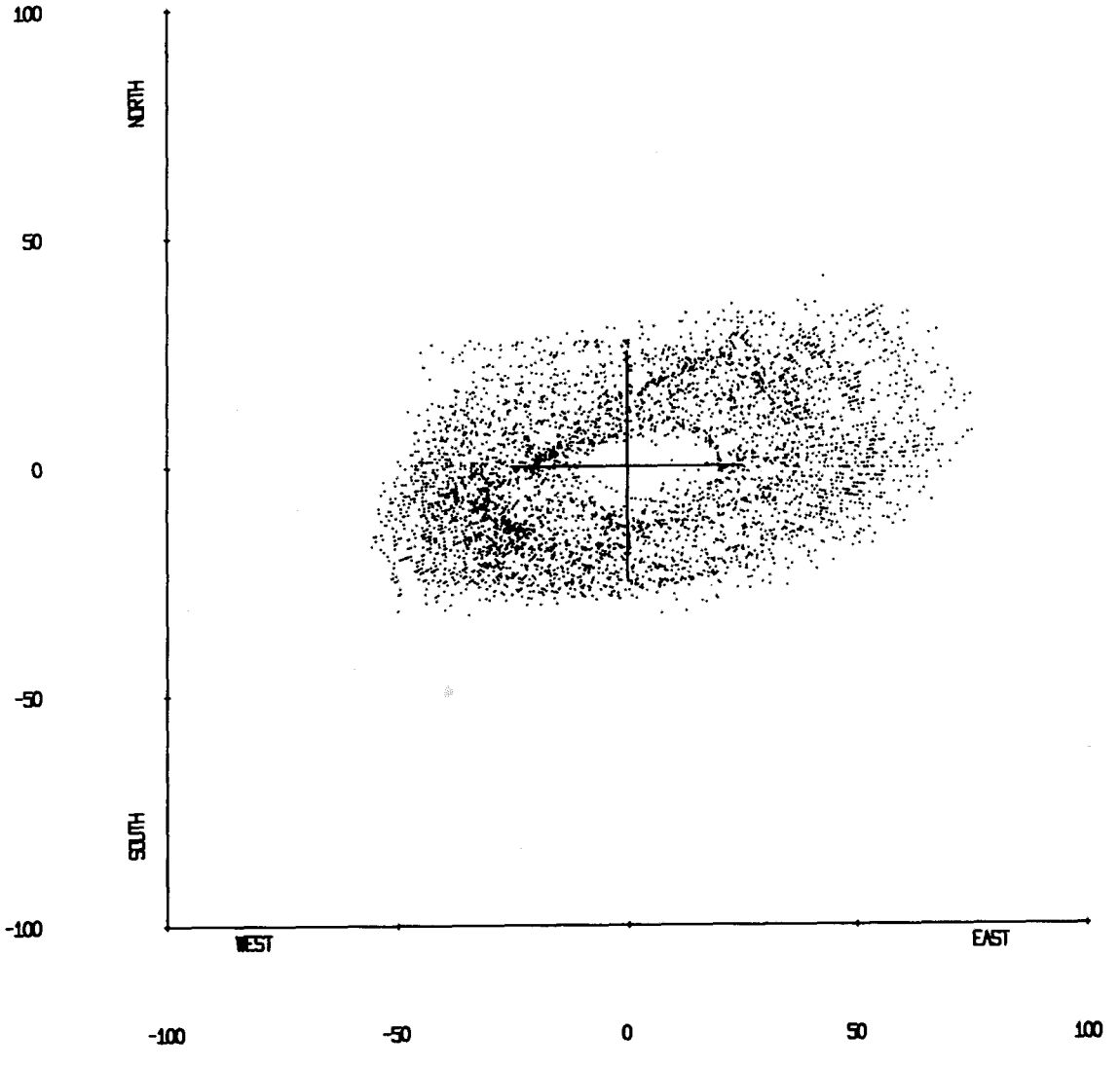
WEST

-100 -50 0 50 100

100 50 0 -50 -100

EAST


PER CENT
60
50
40
30
20
10
0
0
25
50
75
0
90
180
270
360
SPEED IN CM/SEC
DIRECTION


100
50
0
-50
-100
NORTH
SOUTH
WEST
EAST
-100
-50
0
50
100

24'ST MAR 77
28'TH MAR 77
4'TH APR 77
11'TH APR 77
18'TH APR 77

WEST
SOUTH
NORTH
EAST
24'ST MAR 77
28'TH MAR 77
4'TH APR 77
11'TH APR 77
18'TH APR 77

Mooring number : 131

Position of rig : LAT 53°53.9'N 4°46.2'W (RIG 19)

Depth of water : 71m below chart datum

Tidal heights, in metres above chart datum, at Hilbre Island :

MHWS	MHWN	MLWN	MLWS
8.6	6.7	2.5	0.8

Meter	Type	Height above sea floor (m)	Recording interval (min)
570	Aanderaa RCM4	51	10
567	Aanderaa RCM4	8	10

Rig set : 18.28 GMT 24 March 1977 from R.R.S. 'John Murray'

Rig recovered : 08.36 GMT 25 April 1977 from R.R.S. 'John Murray'

Mooring : Standard

Comments : The rig was deployed on 19 March but when it was checked on 24 March the sub-surface buoy was on the surface since the rig had been deployed in shallower water than planned. The rig was recovered and a site 8km NNW in deeper water chosen. After the current meter anchor had been deployed the main winch failed. Repairs took 3 hours before the launch was successfully completed.

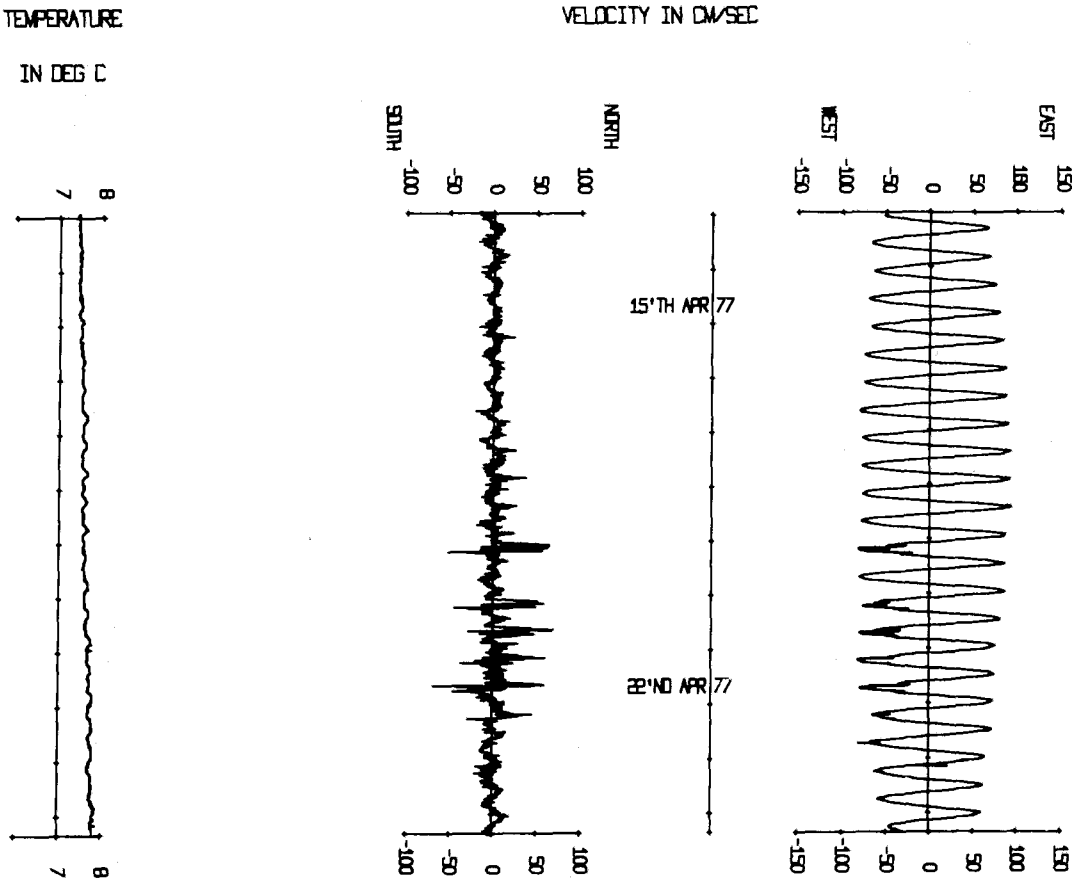
The recovery was successful at the first attempt despite 25 knot winds and rough seas. The surface buoy was upside down, and the surface buoy anchor was missing. The condition of the anchor strop indicated that the loss occurred before recovery.

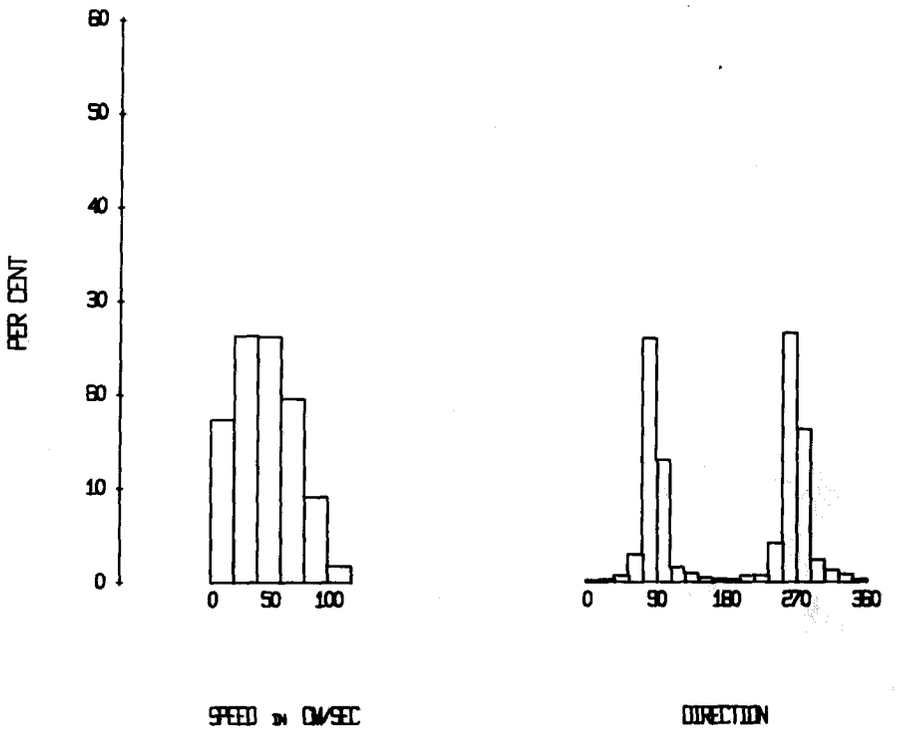
Meter	:	Aanderaa 570
Tape number	:	570/8
Meter started	:	17.40.25 GMT 19 March 1977
Meter stopped	:	09.49.34 GMT 25 April 1977
Total number of readings	:	5282
Timing error	:	51 s fast
Start of useful record	:	18.41 GMT 24 March 1977
End of useful record	:	00.50 GMT 20 April 1977
Length of useful record	:	630 h
Comments	:	The meter was fitted with a modified spindle and an experimental elapsed time counter which recorded on channel 3. When it was recovered there were deep wire marks on the spindle and casting. For the last 5 days of the record there are many direction errors on the ebb tide - all the information is consistent with the surface buoy line fouling the current meter. The full record till 08.20 on 25 April is displayed in all plots except the scatter plot. The temperature record is good throughout.

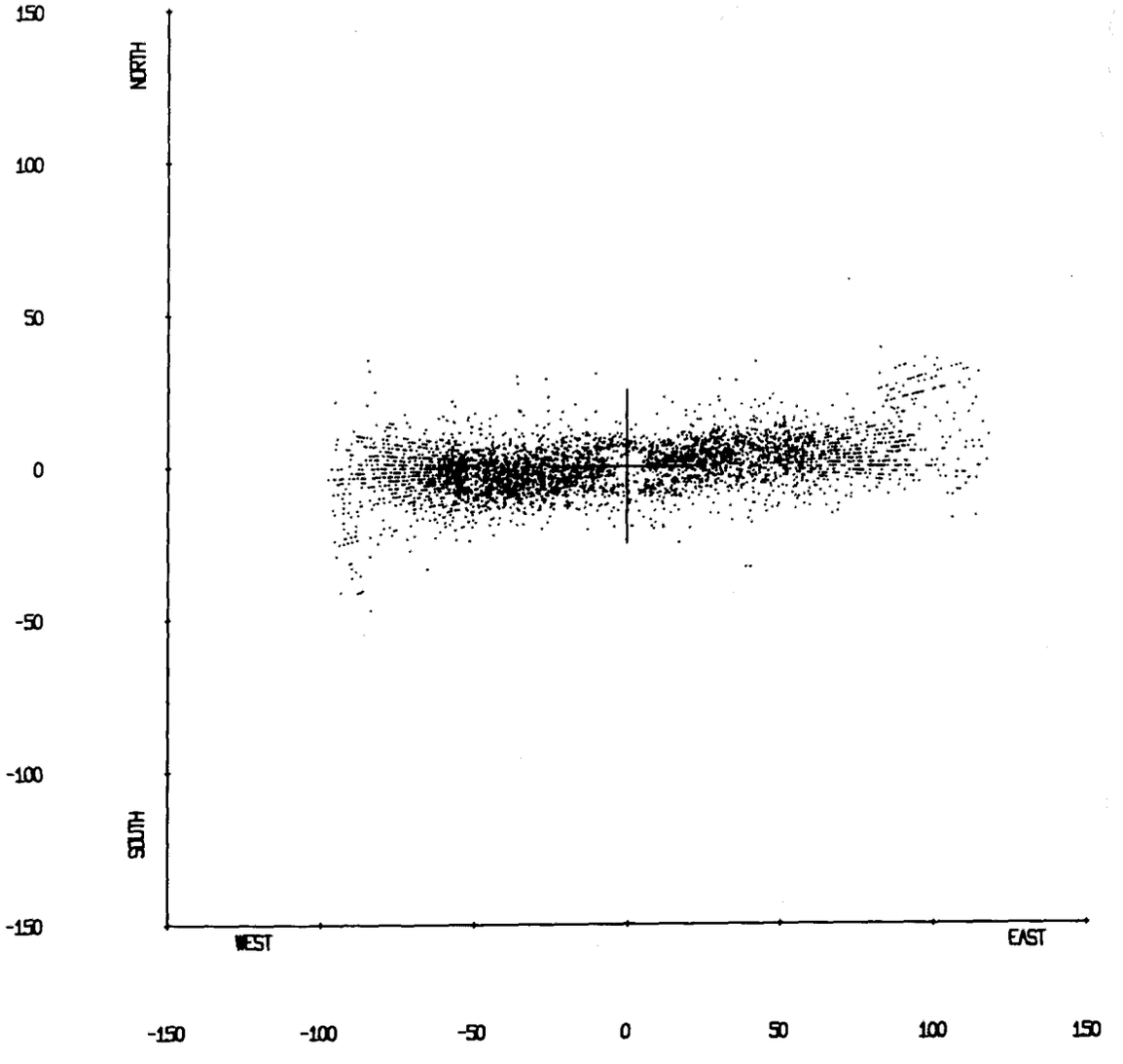
TEMPERATURE

IN DEG C

VELOCITY IN CM/SEC


TEMPERATURE
IN DEG C
7
8
7
8
VELOCITY IN CM/SEC
SOUTH
NORTH
-100
-50
0
50
100
-100
-50
0
50
100
15'TH APR 77
22'ND APR 77
WEST
EAST
-150
-100
-50
0
50
100
150
-150
-100
-50
0
50
100
150

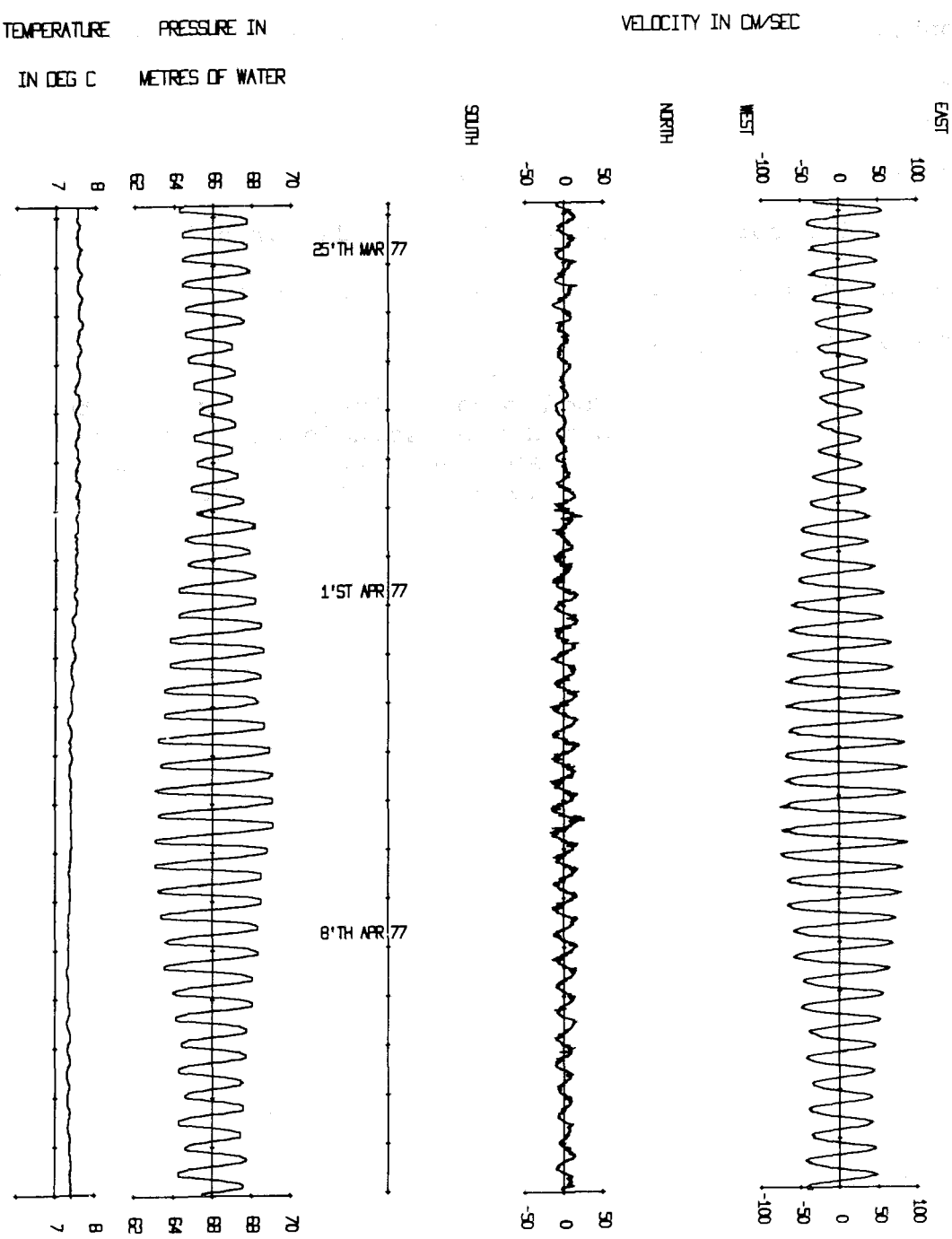

PER CENT
60
50
40
30
20
10
0
0
50
100
0
90
180
270
360
SPEED IN CM/SEC
DIRECTION


NORTH
SOUTH
WEST
EAST
150
100
50
0
-50
-100
-150
-150
-100
-50
0
50
100
150

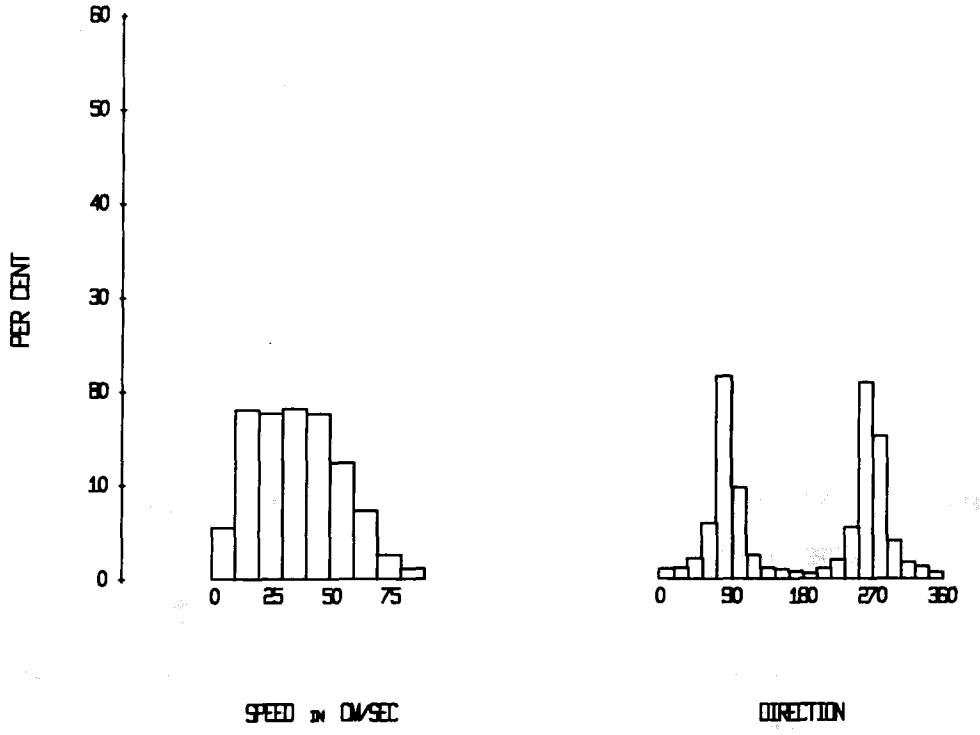
15TH APR 77
22ND APR 77
8TH APR 77
1ST APR 77
25TH APR 77

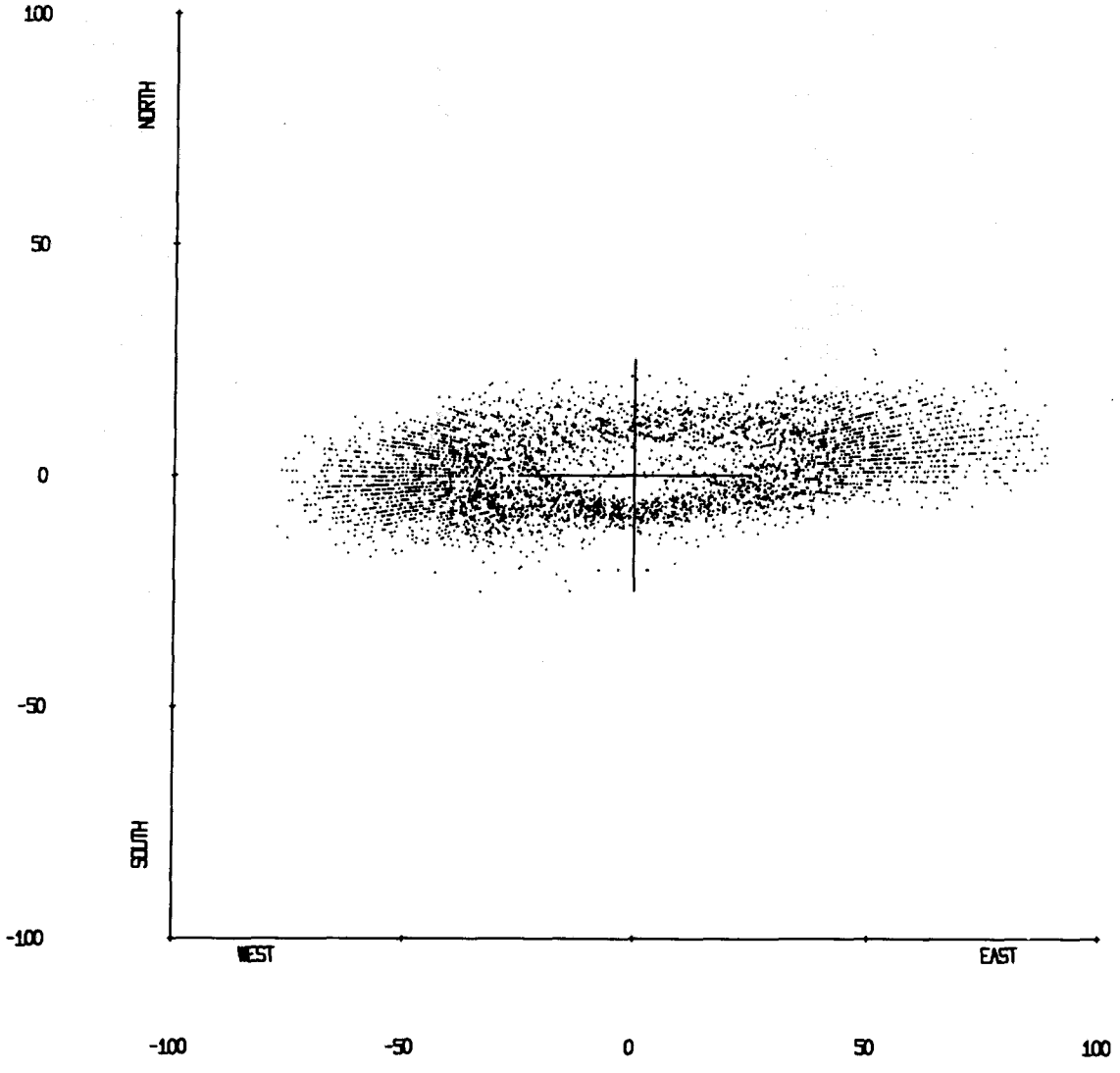
WEST
EAST
SOUTH
NORTH
15TH APR 77
22ND APR 77
8TH APR 77
1ST APR 77
25TH APR 77

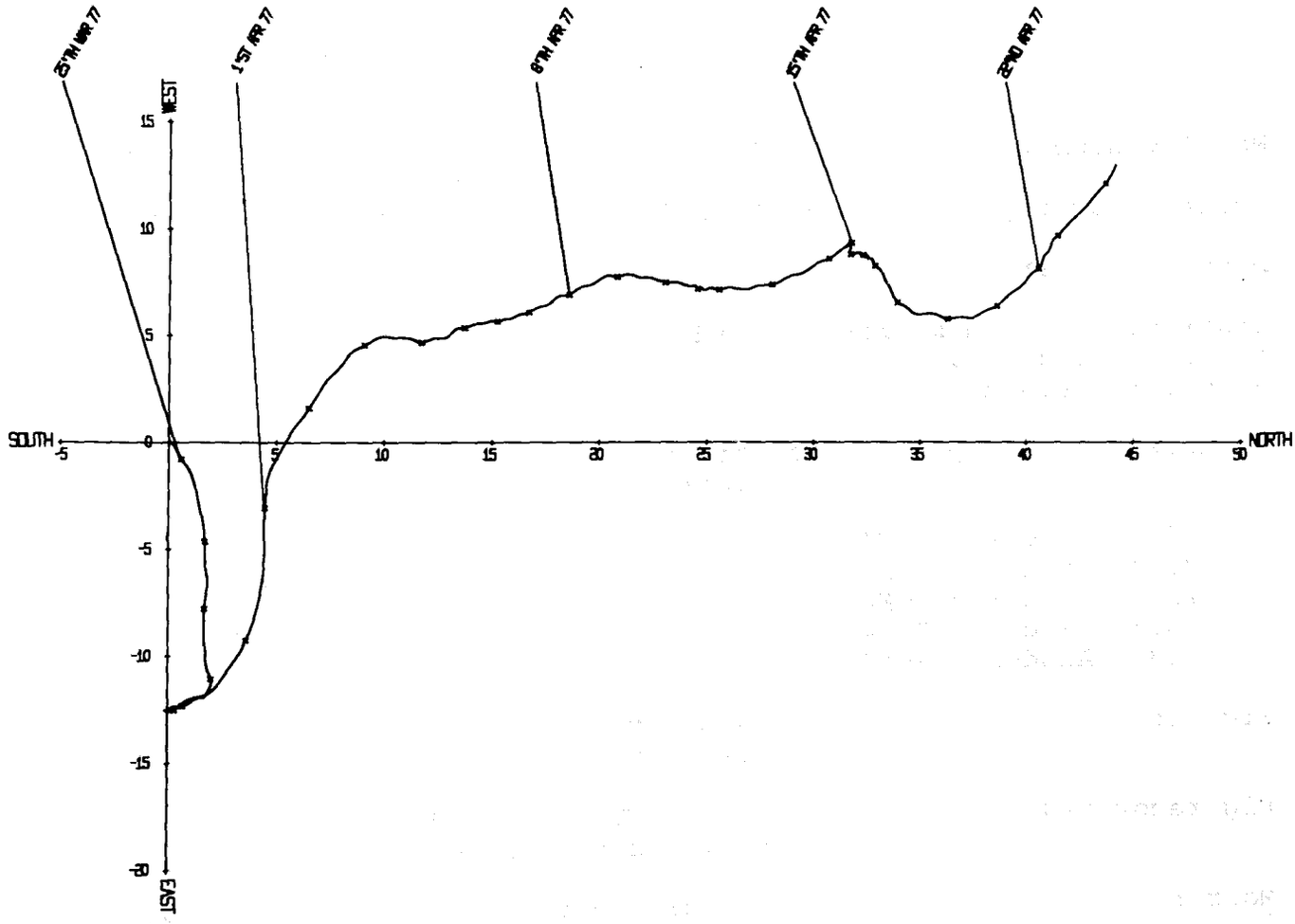
Meter	:	Aanderaa 567
Tape number	:	567/7
Meter started	:	17.10.00 GMT 19 March 1977
Meter stopped	:	10.00.39 GMT 25 April 1977
Total number of readings	:	5286
Timing error	:	39s slow
Start of useful record	:	18.40 GMT 24 March 1977
End of useful record	:	08.21 GMT 25 April 1977
Length of useful record	:	757 h
Comments	:	Good record. The meter was fitted with a modified spindle and a 0-200 PSI pressure sensor. The meter was recovered in good conditon.

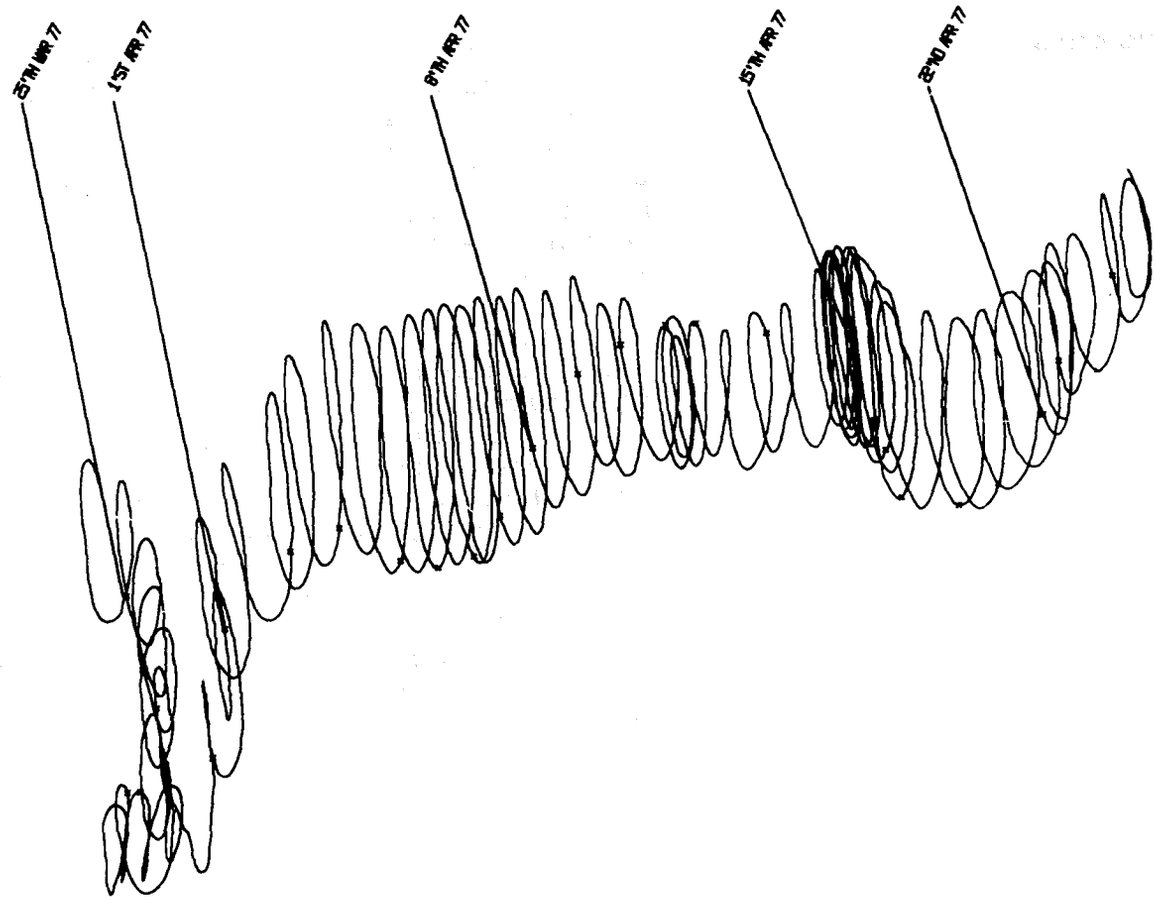

TEMPERATURE
IN DEG C
PRESSURE IN
METRES OF WATER
VELOCITY IN CM/SEC
SOUTH
NORTH
WEST
EAST
25'TH MAR 77
1'ST APR 77
8'TH APR 77
7
8
60
64
68
72
-50
0
50
-100
-50
0
50
100

TEMPERATURE
IN DEG C
PRESSURE IN
METRES OF WATER
VELOCITY IN CM/SEC
SOUTH
NORTH
WEST
EAST
15'TH APR 77
22'ND APR 77


60
50
40
30
20
10
0
PER CENT
0
25
50
75
SPEED IN CM/SEC
0
90
180
270
360
DIRECTION


100
50
0
-50
-100
NORTH
SOUTH
WEST
EAST
-100
-50
0
50
100


25TH MAR 77
1ST APR 77
8TH APR 77
15TH APR 77
22ND APR 77
WEST
EAST
SOUTH
NORTH
15
10
5
0
-5
-10
-15
-20
-5
0
5
10
15
20
25
30
35
40
45
50


25TH MAR 77
1ST APR 77
8TH APR 77
15TH APR 77
22ND APR 77

Mooring number : 137

Position of rig : LAT 53°45.8'N LONG 4°7.10'W (RIG D)

Depth of water : 42m below chart datum

Tidal heights, in metres above chart datum, at Hilbre Island :

MHWS	MHWN	MLWN	MLWS
8.6	6.7	2.5	0.8

Meter	Type	Height above sea floor (m)	Recording interval (min)
567	Aanderaa RCM4	22	15
2574	Aanderaa RCM4	19	0.5
2575	Aanderaa RCM4	16	15
1865	Aanderaa RCM4	11	0.5
1139	Aanderaa RCM4	8	15

Rig set : 18.46 GMT 17 Oct 1977 from R.V. 'Prince Madog'

Rig recovered : 15.55 GMT 25 Nov 1977 from R.V. 'Prince Madog'

Mooring : Standard with 1m sub-surface buoy. The meter anchor was a ballast frame which housed two pressure recorders and an acoustic release.

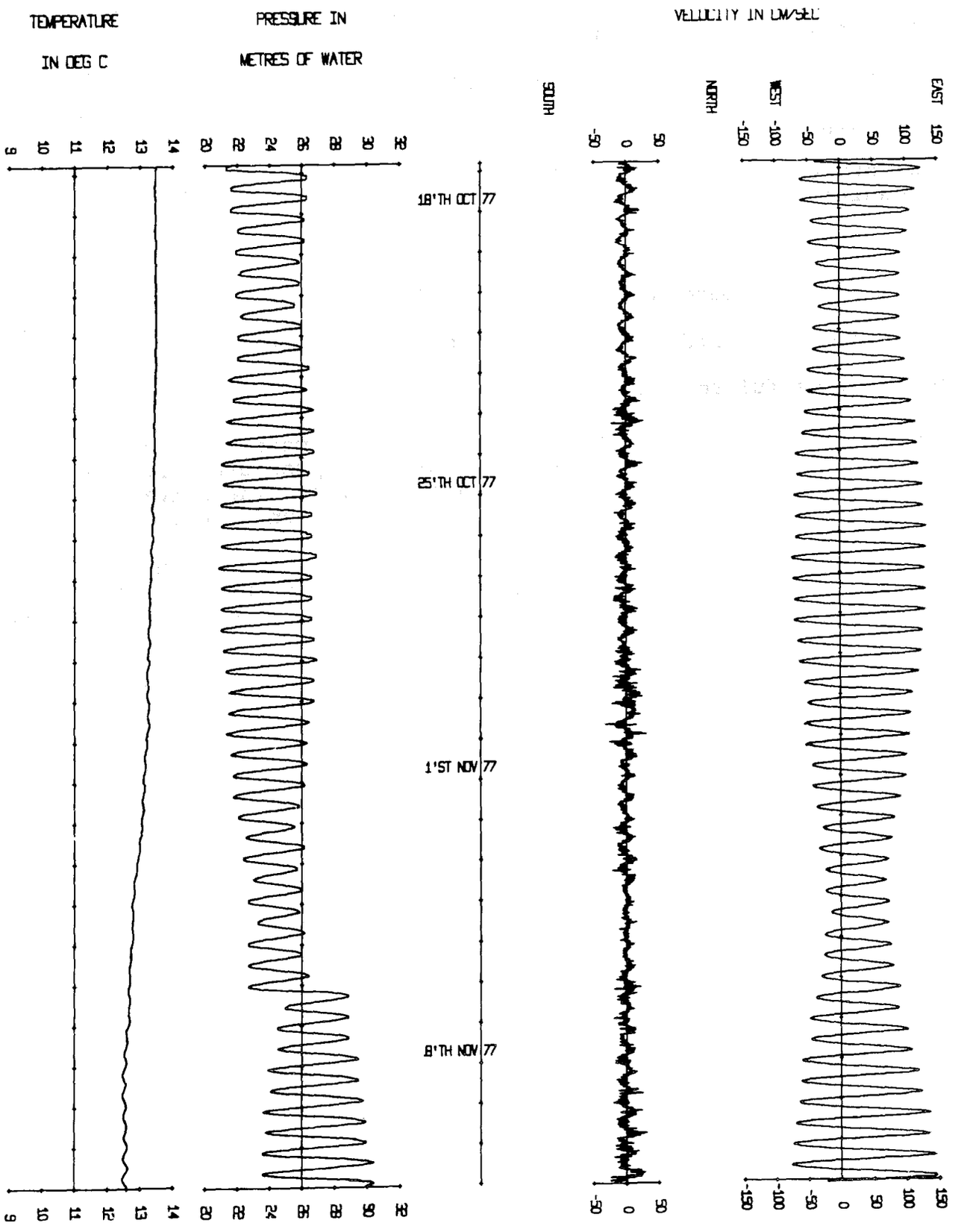
Comments : The launch and recovery were successfully accomplished at the first attempt. During the launch the rotor from meter 1867 was smashed and replaced. For this launch the ship was not anchored but its engines were switched off and so considerable stress was put on the wire as the ship drifted.

On recovery the toroid anchor was missing and the ground line was stranded near the toroid anchor end. The acoustic release was fired but the sub-surface buoy did not come to the surface since the bottom frame had tangled with a safety strop. The bottom frame looked as though it had been upside down throughout the exercise.

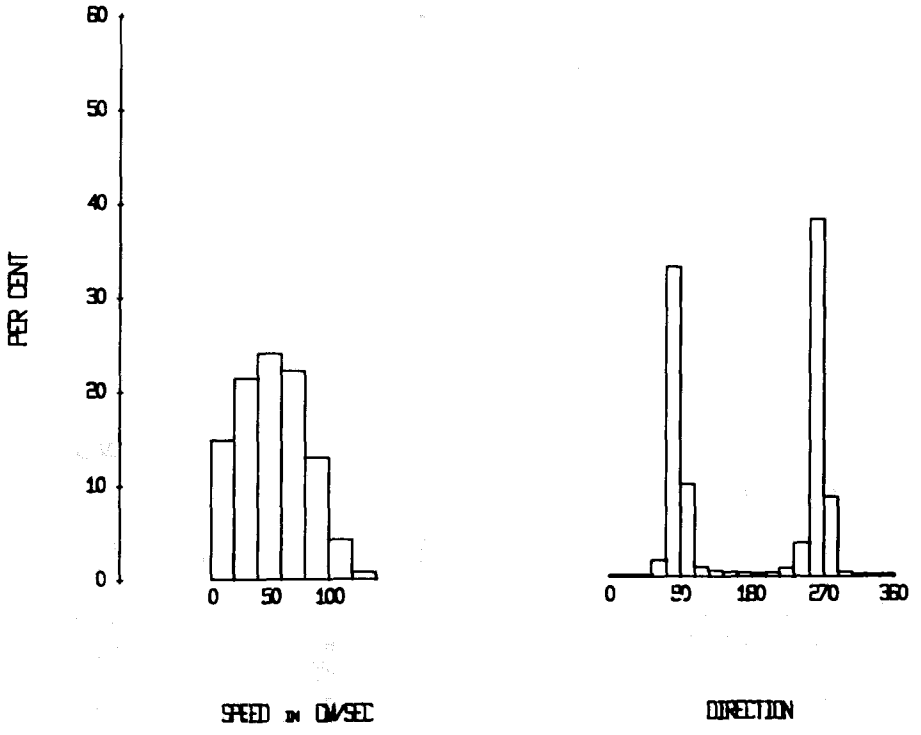
Notice the 3m increase in depth on 7 Nov. which is shown by all current meters and pressure recorders. There was no corresponding current spike.

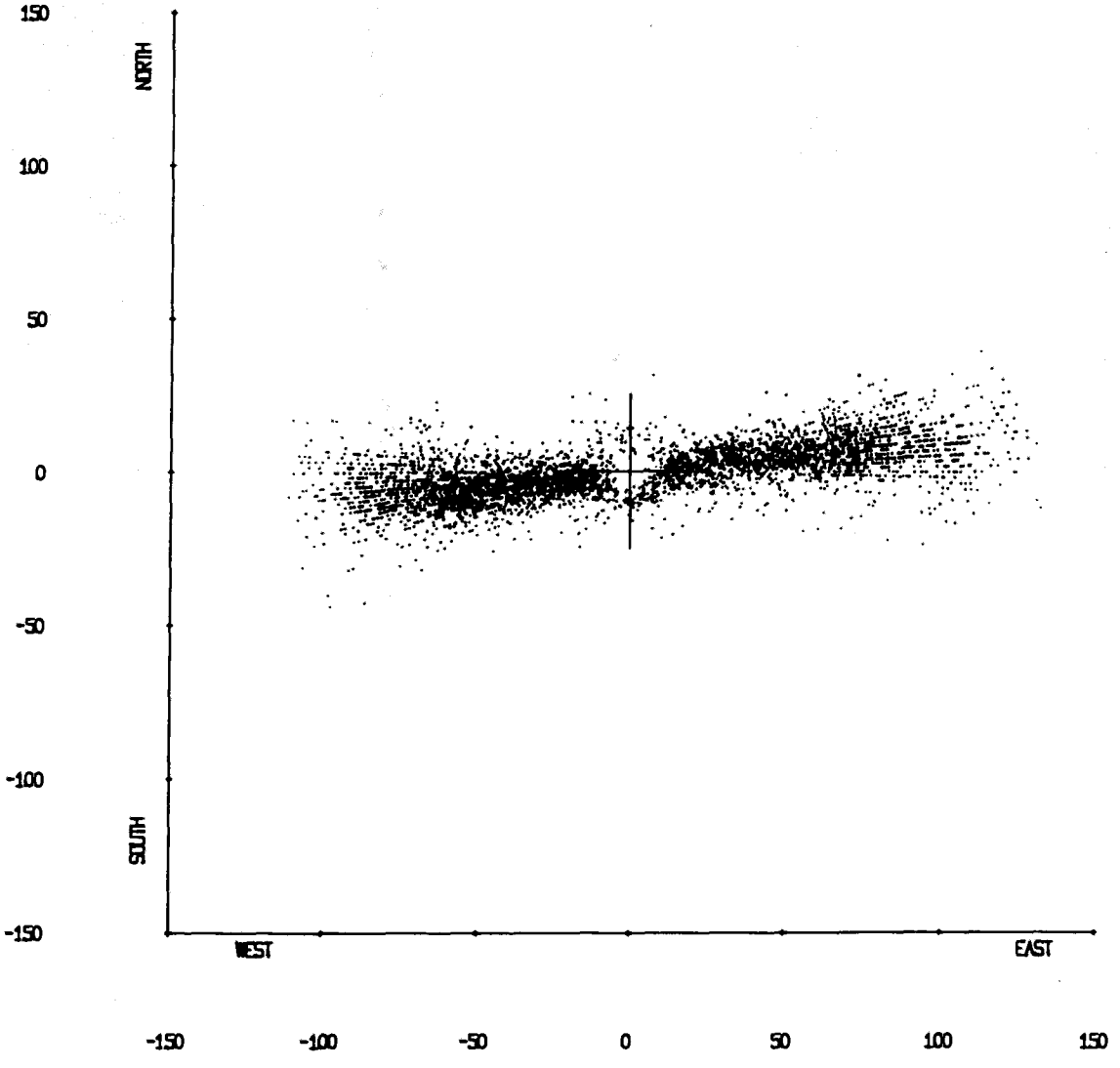
Meter	:	Aanderaa 567
Tape number	:	567/8
Meter started	:	15.22.24 GMT 6 Oct 1977
Meter stopped	:	10.07.22 GMT 29 Nov 1977
Total number of readings	:	5164
Timing error	:	2 s fast
Start of useful record	:	19.08 GMT 17 Oct 1977
End of useful record	:	15.38 GMT 25 Nov 1977
Length of useful record	:	932 h
Comments	:	Good record. The meter was fitted with a 0-200 PSI pressure sensor and a modified spindle. The meter was recovered in good condition.

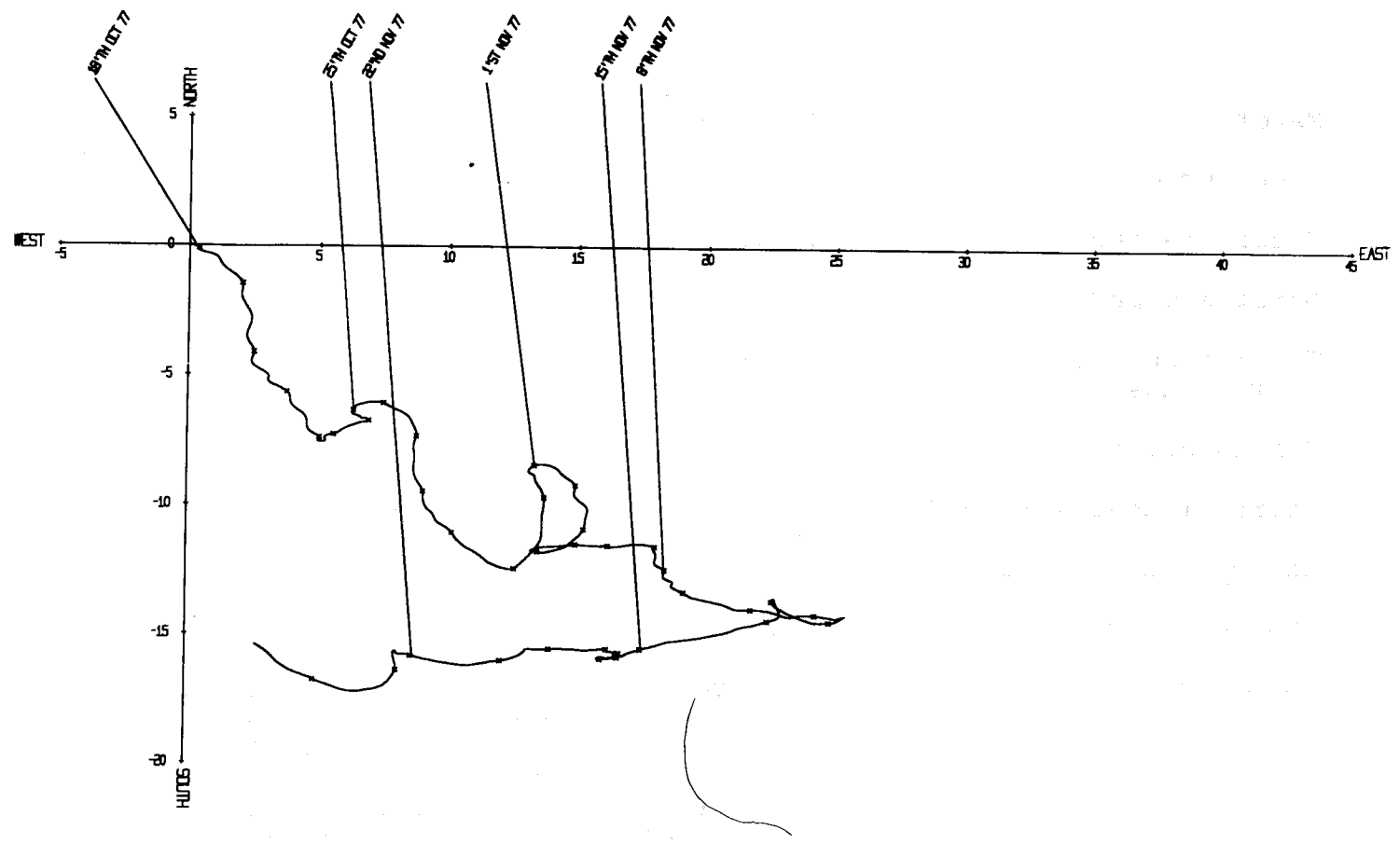
NOTE: In the first and second plots the scale for the East component should have 20 cm/sec subtracted from it.

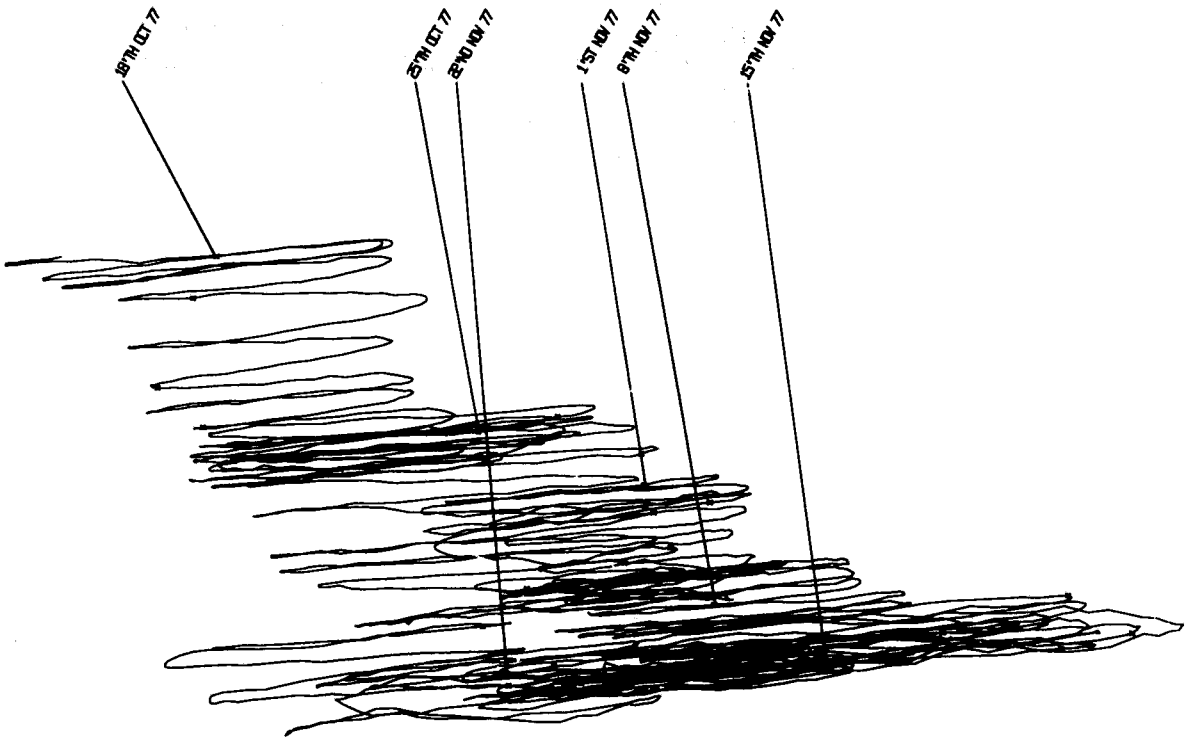

TEMPERATURE
IN DEG C
PRESSURE IN
METRES OF WATER
VELOCITY IN CM/SEC
EAST
WEST
NORTH
SOUTH
18'TH OCT 77
25'TH OCT 77
1'ST NOV 77
8'TH NOV 77

TEMPERATURE
IN DEG C
PRESSURE IN
METRES OF WATER
VELOCITY IN CM/SEC
SOUTH
NORTH
WEST
EAST
15'TH NOV 77
22'ND NOV 77


PER CENT
60
50
40
30
20
10
0
0
50
100
0
90
180
270
360
SPEED IN CM/SEC
DIRECTION


NORTH
SOUTH
WEST
EAST
150
100
50
0
-50
-100
-150
-150
-100
-50
0
50
100
150

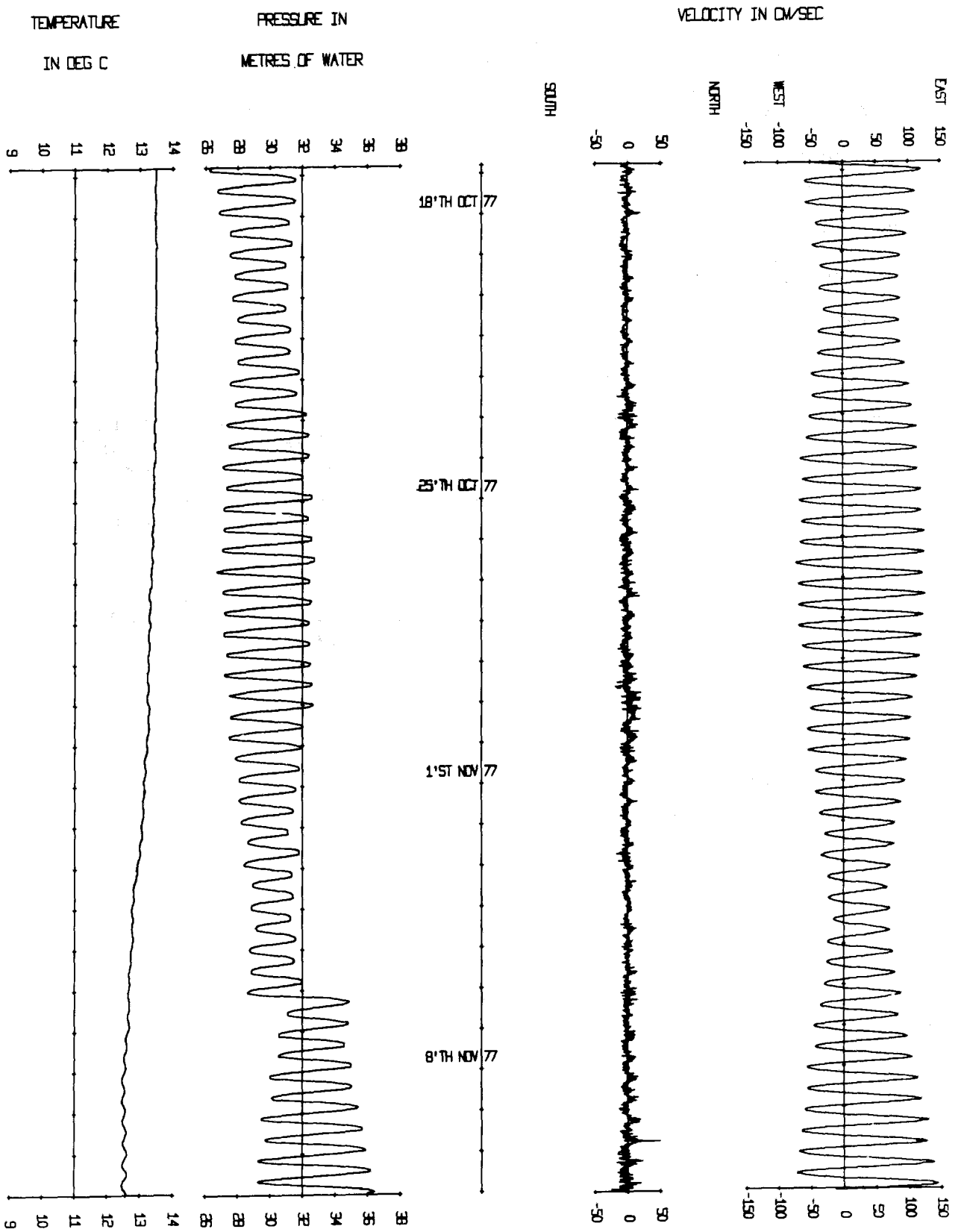

18TH OCT 77
25TH OCT 77
22ND NOV 77
1ST NOV 77
15TH NOV 77
8TH NOV 77
NORTH
WEST
EAST
SOUTH
5
0
-5
10
15
20
25
30
35
40
45
-10
-15

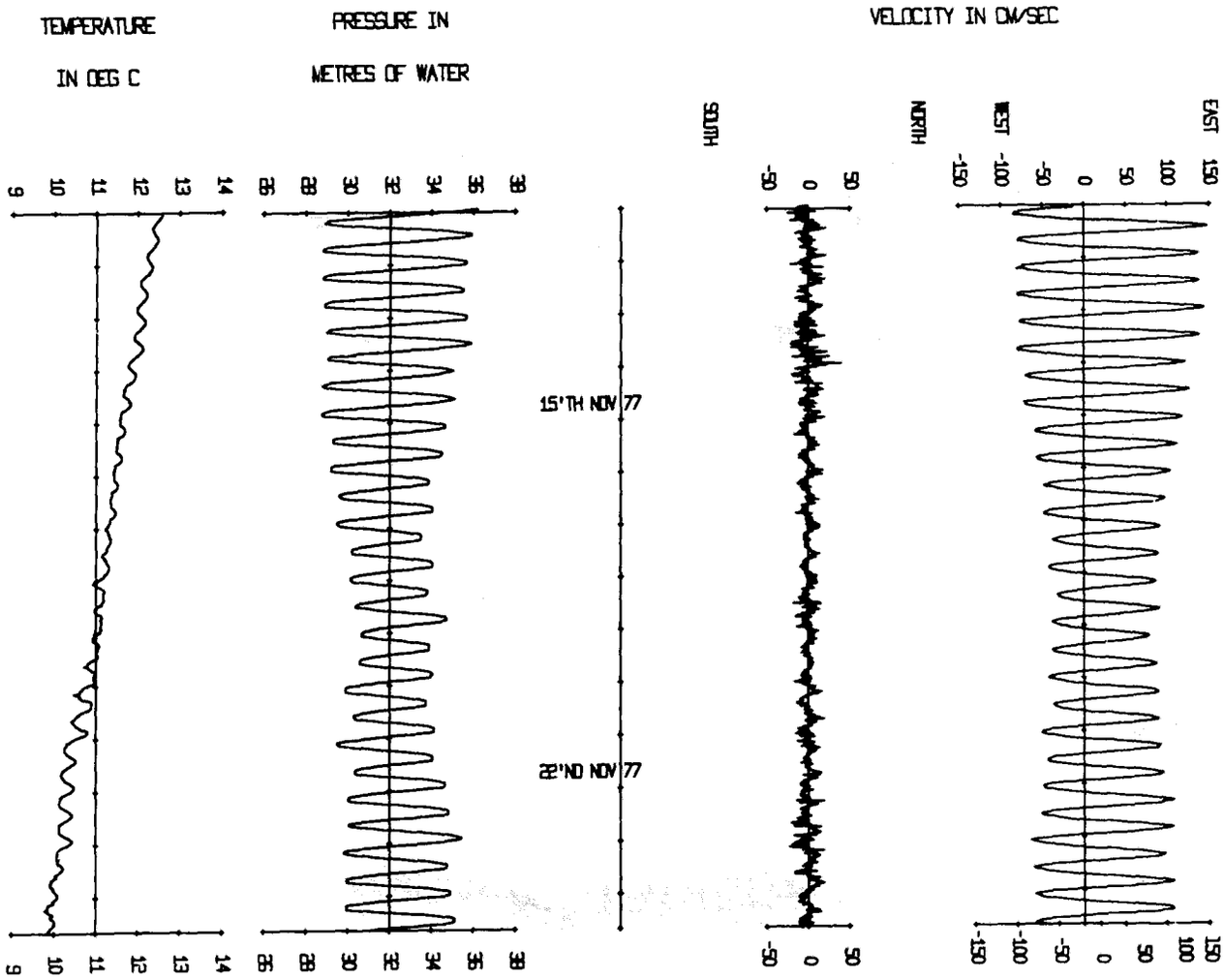

18TH OCT 77
25TH OCT 77
22ND NOV 77
1ST NOV 77
8TH NOV 77
15TH NOV 77

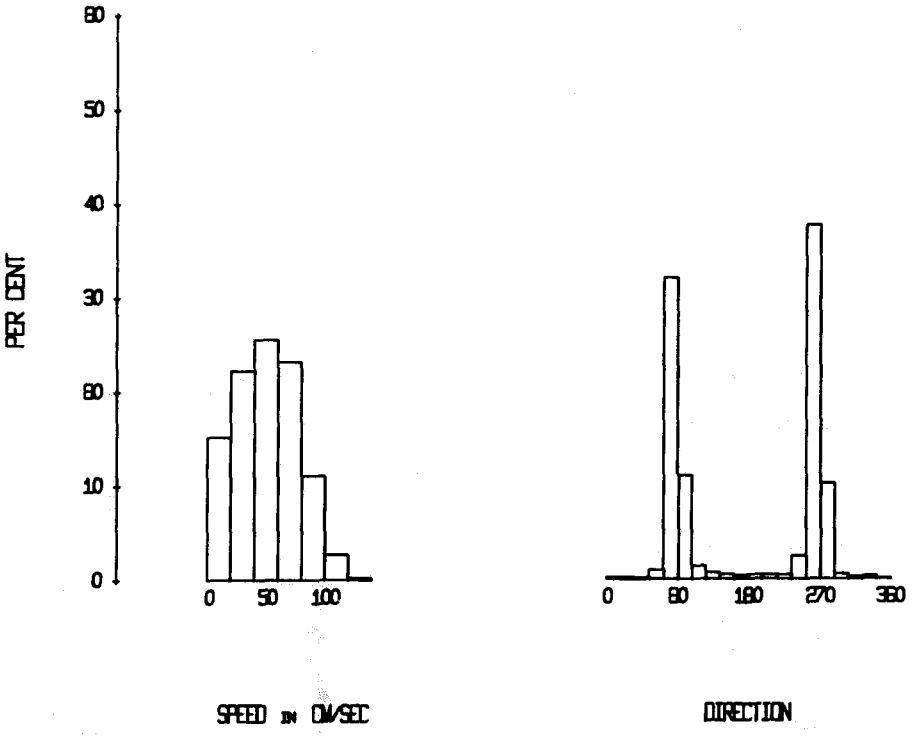
Meter	:	Aanderaa 2574
Tape number	:	2574/2
Meter started	:	17.16.30 GMT 17 Oct 1977
Meter stopped	:	-
Total number of readings	:	10206
Timing error	:	-
Start of useful record	:	18.46.30 GMT 17 Oct 1977
End of useful record	:	06.19.00 GMT 21 Oct 1977
Length of useful record	:	83.5 h
Comments	:	Good record. The meter, without its vane, was clamped to the wire and was fitted with a 2-D liquid resistance tiltmeter. When the meter was recovered the bottom rotor bearing was out of its socket but still attached to the rotor - and some plastic was wrapped round the rotor. There were signs of corrosion around the clamp which held the meter to the wire. No graphs are displayed for this meter.

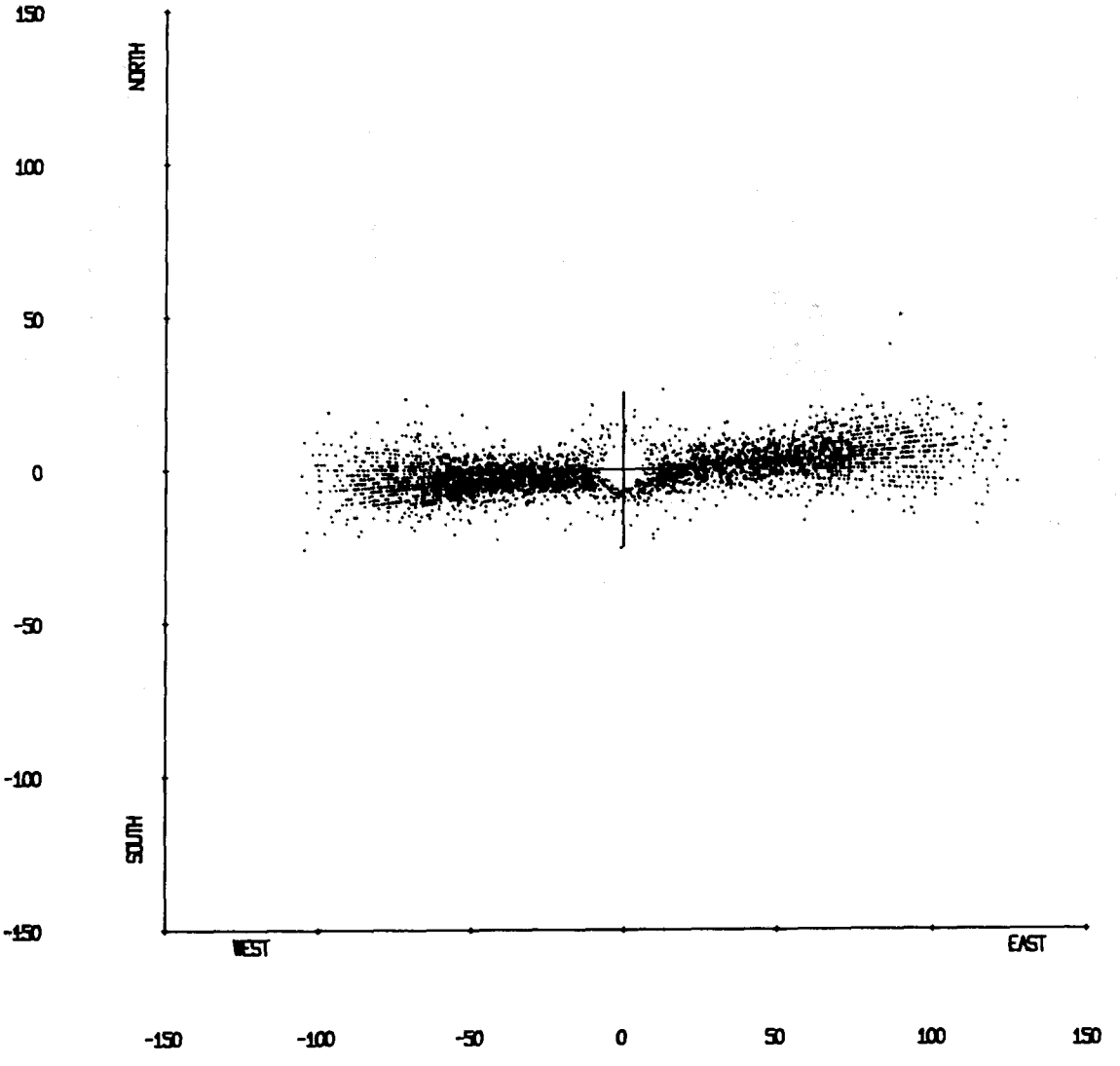
Meter	:	Aanderaa 2575
Tape number	:	2575/3
Meter started	:	15.37.24 GMT 6 Oct 1977
Meter stopped	:	10.07.27 GMT 29 Nov 1977
Total number of readings	:	5163
Timing error	:	3s slow
Start of useful record	:	19.08 GMT 17 Oct 1977
End of useful record	:	15.38 GMT 25 Nov 1977
Length of useful record	:	932 h
Comments	:	Good record. The meter was fitted with a 0-100 PSI pressure sensor and an Aanderaa spindle. The meter was recovered in good condition. There were very few errors in the record.

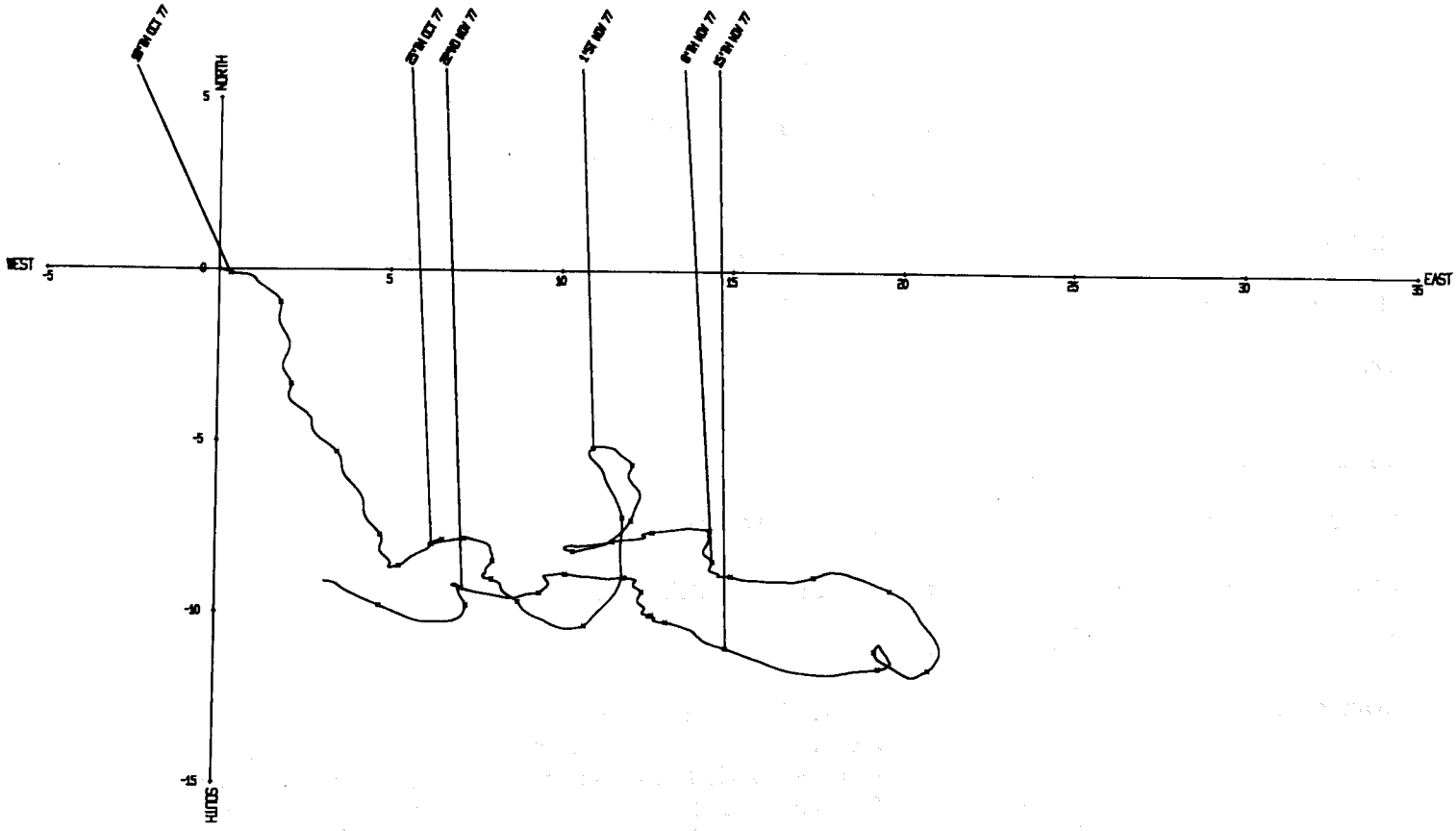
NOTE: In the first and second plots 20 cm/sec should be subtracted from the scale of the east component.

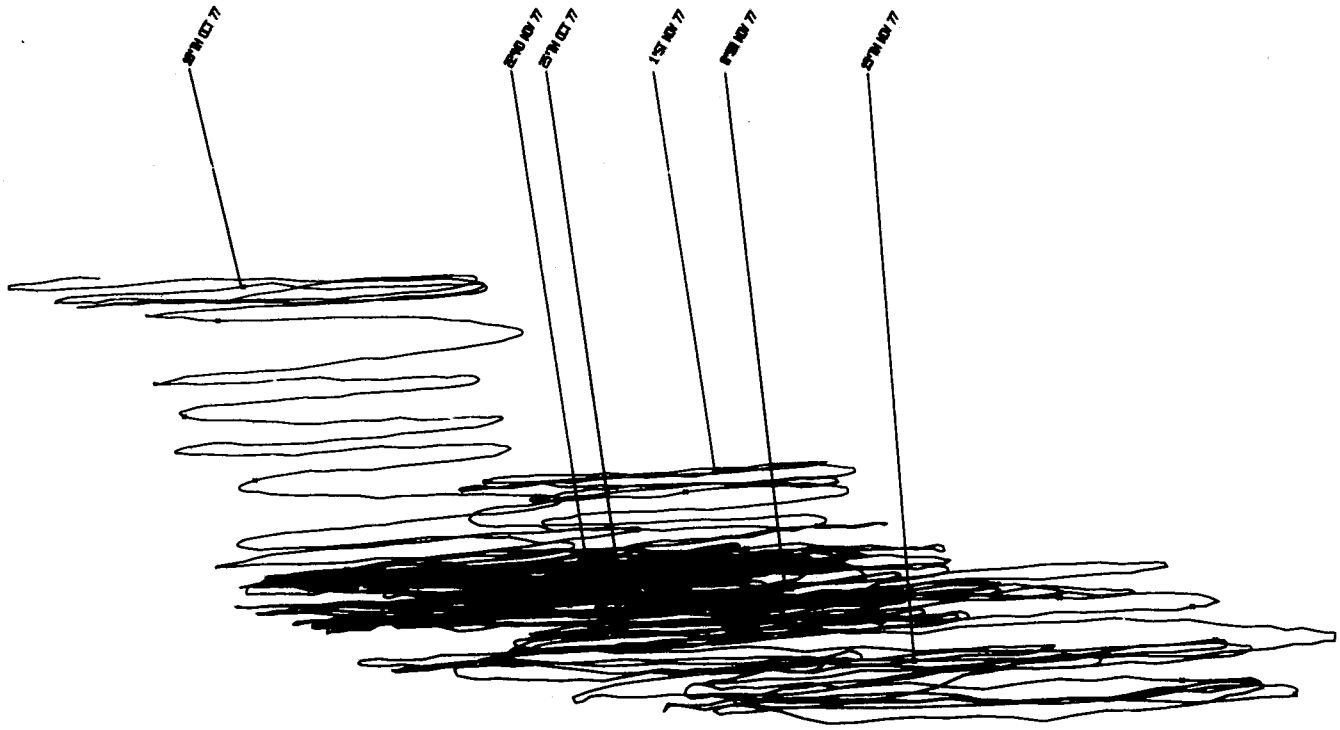

TEMPERATURE
IN DEG C
PRESSURE IN
METRES OF WATER
VELOCITY IN CM/SEC
SOUTH
NORTH
WEST
EAST
18'TH OCT 77
25'TH OCT 77
1'ST NOV 77
8'TH NOV 77


TEMPERATURE
IN DEG C
PRESSURE IN
METRES OF WATER
VELOCITY IN CM/SEC
SOUTH
NORTH
WEST
EAST
15'TH NOV 77
22'ND NOV 77


PER CENT
60
50
40
30
20
10
0
0
50
100
0
90
180
270
360
SPEED IN CM/SEC
DIRECTION

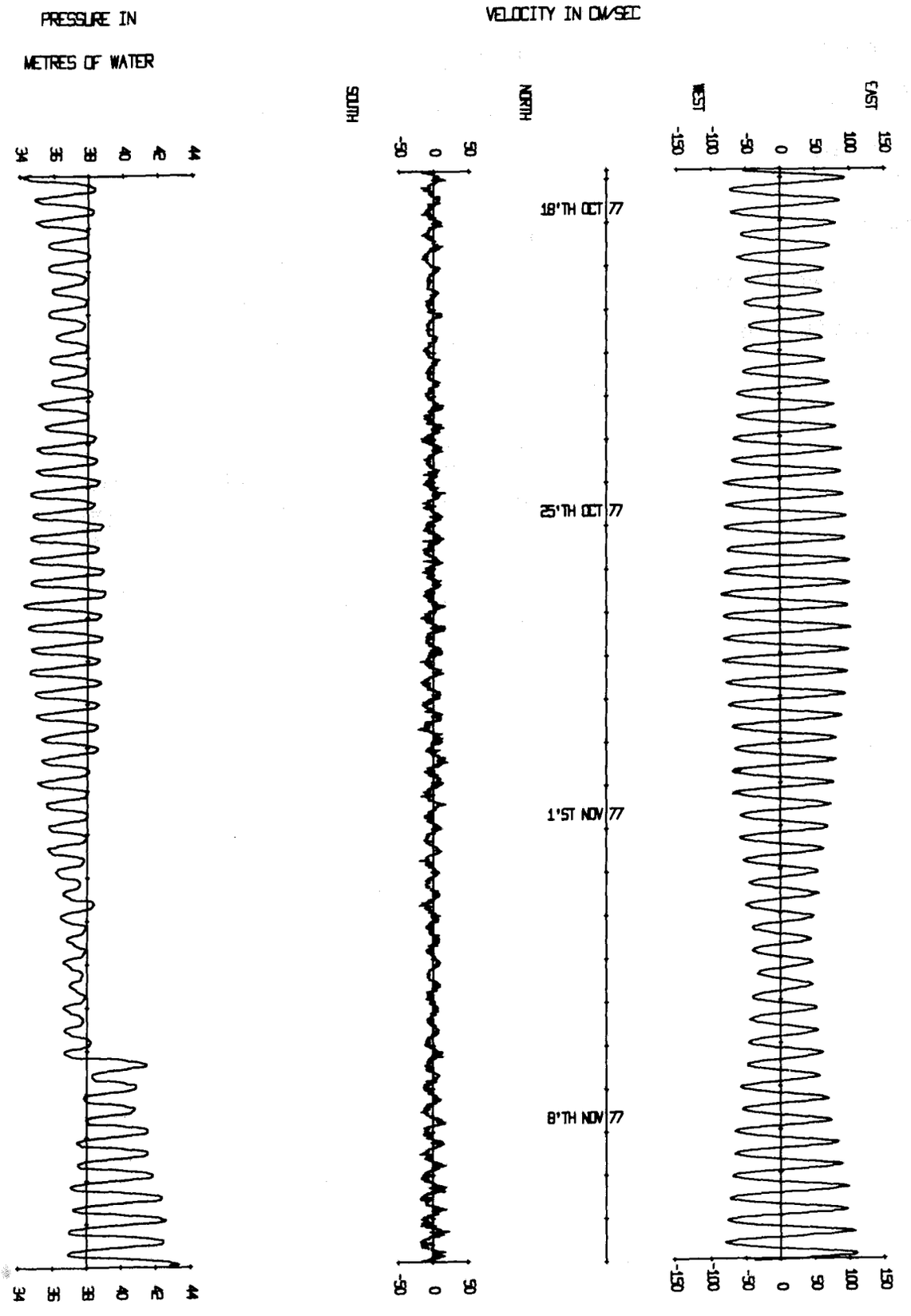

150
100
50
0
-50
-100
-150
NORTH
SOUTH
WEST
EAST
-150
-100
-50
0
50
100
150


NORTH
SOUTH
WEST
EAST
5
0
-5
-10
-15
5
10
15
20
25
30
35

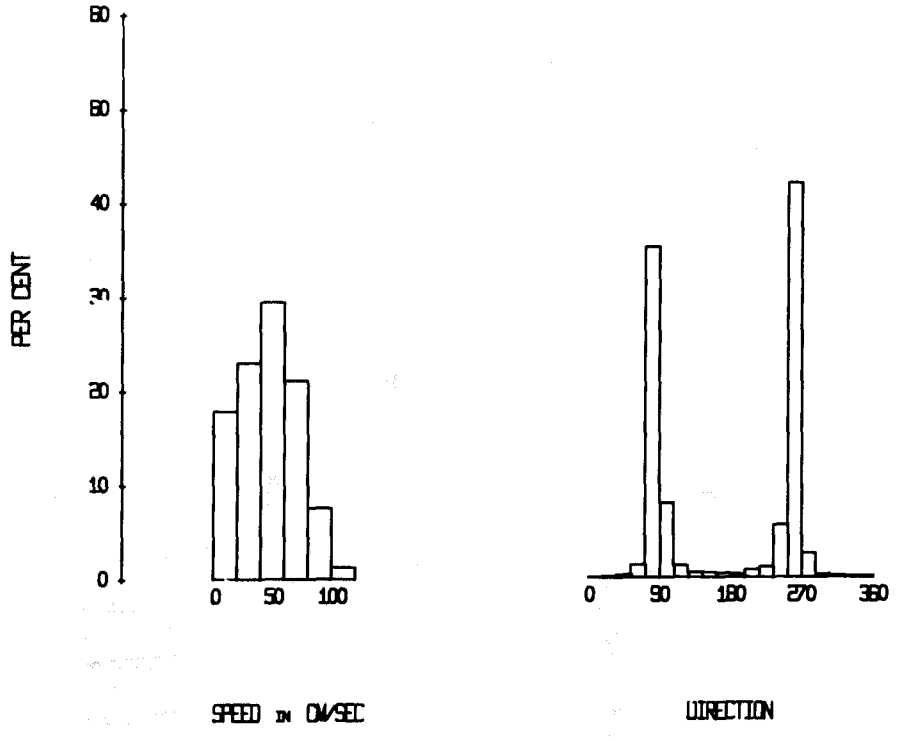


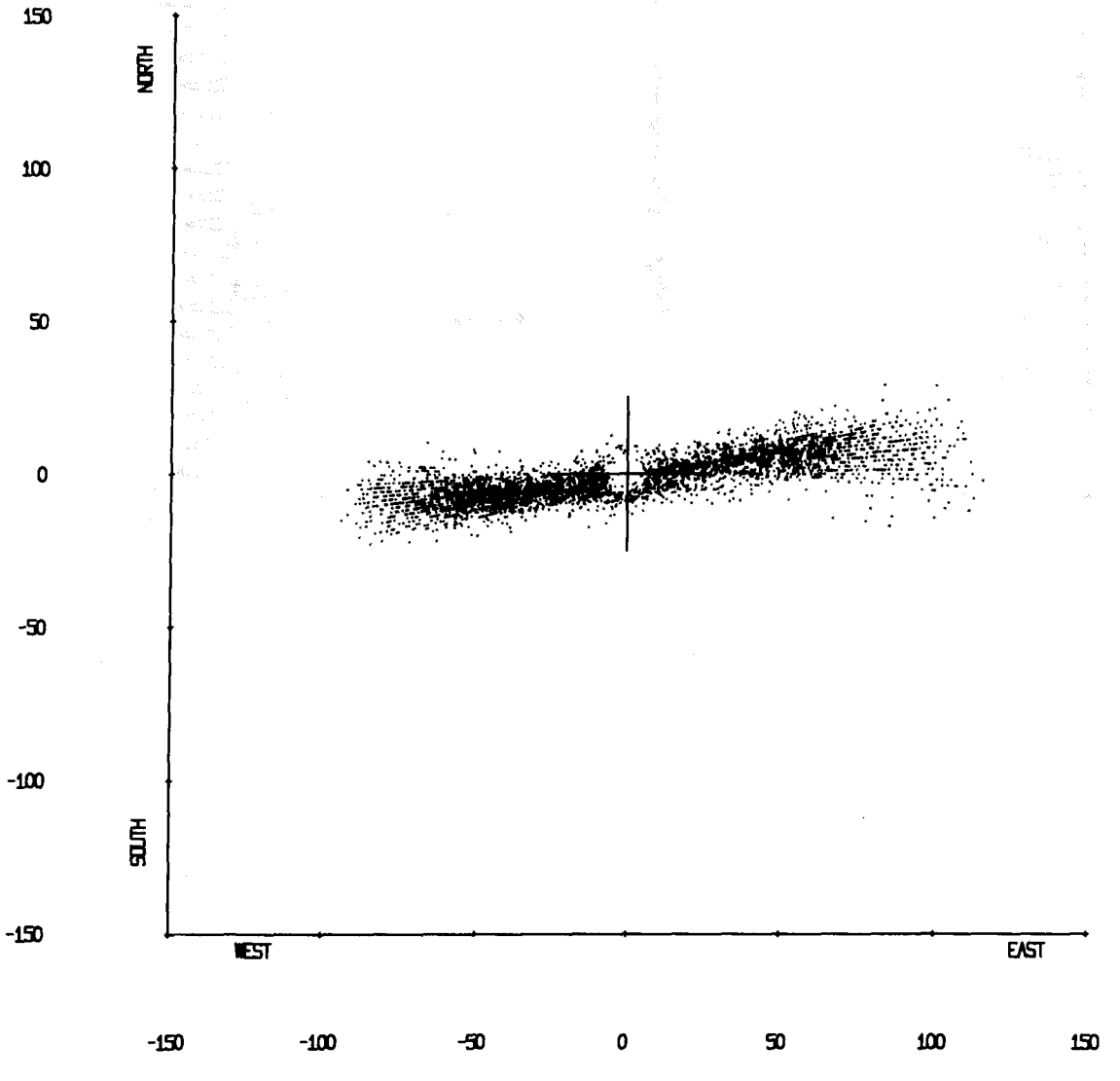
Meter	:	Aanderaa 1865
Tape number	:	1865/2
Meter started	:	16.05.16 GMT 17 Oct 1977
Meter stopped	:	-
Total number of readings	:	9790
Timing error	:	-
Start of useful record	:	18.46.46 GMT 17 Oct 1977
End of useful record	:	01.39.16 GMT 21 Oct 1977
Length of useful record	:	78.8 h
Comments	:	Good record. The meter was fitted with a 2-D liquid resistance inclinometer and a modified spindle. It was recovered in good condition apart from a stiff spindle. No graphs are displayed for this meter.

Meter	:	Aanderaa 1139
Tape number	:	1139/8
Meter started	:	17.37.24 GMT 6 Oct 1977
Meter stopped	:	10.08.20 GMT 29 Nov 1977
Total number of readings	:	5155
Timing error	:	56 s slow
Start of useful record	:	19.08 GMT 17 Oct 1977
End of useful record	:	15.39 GMT 25 Nov 1977
Length of useful record	:	932 h
Comments	:	The meter was fitted with a 0-100 PSI pressure sensor, a modified spindle and a pendulum inclinometer. On recovery its spindlewas stiff and its fin cracked. There was an encoder fault which became worse as the record progressed and was most prominent in the temperature record, which has not been displayed.


PRESSURE IN
METRES OF WATER
34
36
38
40
42
44
VELOCITY IN CM/SEC
SOUTH
NORTH
-50
0
50
WEST
EAST
-150
-100
-50
0
50
100
150
18'TH OCT 77
25'TH OCT 77
1'ST NOV 77
8'TH NOV 77

PRESSURE IN
METRES OF WATER
VELOCITY IN CM/SEC
SOUTH
NORTH
WEST
EAST
15'TH NOV 77
22'ND NOV 77


PER CENT
0
10
20
30
40
50
60
0
50
100
0
90
180
270
360
SPEED IN CM/SEC
DIRECTION


NORTH
SOUTH
WEST
EAST
150
100
50
0
-50
-100
-150
-150
-100
-50
0
50
100
150

15TH NOV 77
22ND NOV 77
8TH NOV 77
1ST NOV 77
25TH OCT 77
18TH OCT 77
SOUTH
NORTH
WEST
EAST
-50
-45
-40
-35
-30
-25
-20
-15
-10
-5
0
5

15TH NOV 77
22ND NOV 77
8TH NOV 77
1ST NOV 77
25TH OCT 77
18TH OCT 77

Mooring number : 138

Position of rig : LAT 53°43.1'N LONG 4°13.6'W (RIG A)

Depth of water : 42m below chart datum

Tidal heights, in metres above chart datum, at Hilbre Island : MHWS 8.6, MHWN 6.7, MLWN 2.5, MLWS 0.8

Meter	Type	Height above sea floor (m)	Recording interval (min)
0155	VACM	22	15
416	Aanderaa RCM4	21	15

Rig set : 07.51 GMT 18 Oct 1977 from R.V. 'Prince Madog'

Rig recovered : -

Mooring : Standard

Comments : The launch was successfully accomplished at the first attempt.

A short visual and acoustic search on 25 Nov. failed to locate the rig. A 12h drag search from a local fishing vessel was also unfulfilled. The toroid was spotted 3 km east of its launch position on 20 Dec after a search by R.R.S. John Murray. Unfortunately the buoy line parted after 50m had been winched in and further dragging was unsuccessful.

The sub-surface buoy and VACM were washed ashore on Walney Island (54°07.5'N 3°16'W) on 10 Jan 1978. The shackle beneath the VACM has been undone, probably by humans since the other shackles were in good condition.

Meter	:	Aanderaa 416
Tape number	:	416/7
Meter started	:	15.22.24 GMT 6 Oct 1977
Meter stopped	:	-
Total number of readings	:	-
Timing error	:	-
Start of useful record	:	-
End of useful record	:	-
Length of useful record	:	-
Comments	:	The meter was fitted with a 0-200 PSI pressure sensor and a modified spindle. It was not recovered.

Mooring number : 139

Position of rig : LAT 53°35.3'N LONG 4°5.5'W (RIG B)

Depth of water : 44m below chart datum

Tidal heights, in metres above chart datum, at Hilbre Island :

MHWS	MHWN	MLWN	MLWS
8.6	6.7	2.5	0.8

Meter	Type	Height above sea floor (m)	Recording interval (min)
0159	VACM	23	15
1508	Aanderaa RCM4	22	15

Rig set : 13.44 GMT 18 Oct 1977 from R.V. 'Prince Madog'

Rig recovered : 14.00 GMT 28 Nov 1977 from fishing vessel.

Mooring : Standard

Comments : The launch was successfully accomplished at the first attempt.

The toroid was located on 25 Nov on station and the acoustics switched on. However, the toroid line came aboard without the anchor. A Conway fishing vessel was hired on 28 November and the rig dragged for. The ground line was caught and the rig recovered. The buoy line had parted just above the ferrule of the bottom splice.

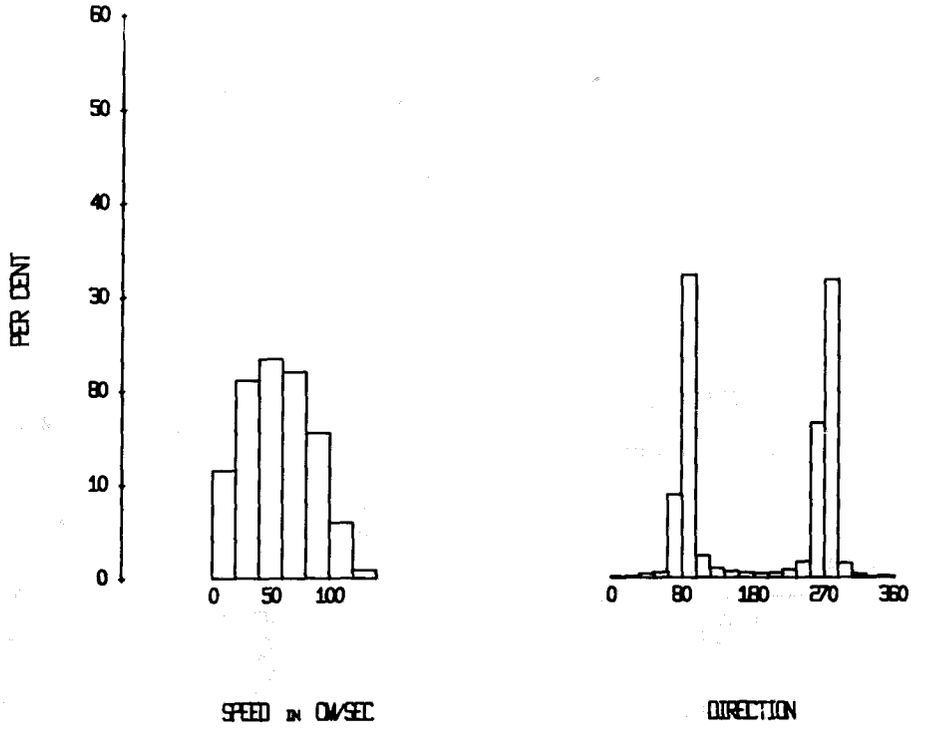
Meter	: Aanderaa 1508	
Tape number	: 1508/5	
Meter started	: 15.52.24 GMT	6 Oct 1977
Meter stopped	: 14.53.00 GMT	29 Nov 1977
Total number of readings	: 5181	
Timing error	: 36s slow	
Start of useful record	: 14.08 GMT	18 Oct 1977
End of useful record	: 13.38 GMT	28 Nov 1977
Length of useful record	: 983h	

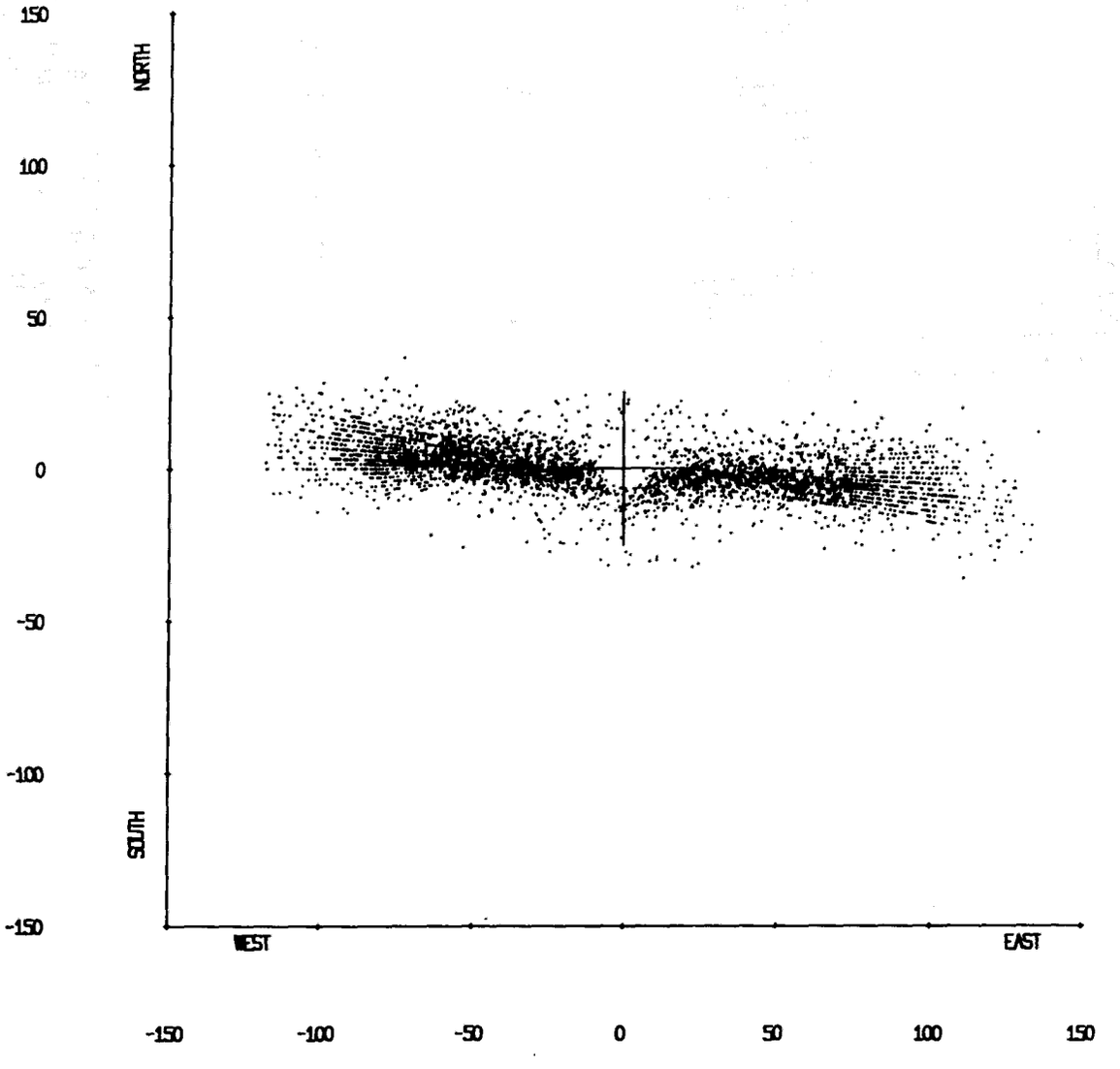
Comments : Good record. The meter was fitted with a 0-100 PSI pressure sensor and a modified spindle. The spindle was stiff when the meter was recovered.

NOTE: In the first two plots the scale for the east component of velocity should have 20 cm/sec subtracted from it.

TEMPERATURE
IN DEG C
PRESSURE IN
METRES OF WATER
VELOCITY IN CM/SEC
SOUTH
NORTH
WEST
EAST
19'TH OCT 77
26'TH OCT 77
2'ND NOV 77
9'TH NOV 77
16'TH NOV 77

TEMPERATURE
IN DEG C
PRESSURE IN
METRES OF WATER
VELOCITY IN CM/SEC
SOUTH
NORTH
WEST
EAST
23'RD NOV 77


PER CENT
60
50
40
30
20
10
0
0
50
100
0
80
180
270
360
SPEED IN CM/SEC
DIRECTION


NORTH
SOUTH
WEST
EAST
150
100
50
0
-50
-100
-150
-150
-100
-50
0
50
100
150

25TH NOV 77
25TH NOV 77
5TH NOV 77
27TH NOV 77
25TH OCT 77
25TH OCT 77
NORTH
EAST
SOUTH
-80
-70
-60
-50
-40
-30
-20
-10
0
10
10
0
-10
-20
-30
-40
-50

25TH NOV 77
25TH NOV 77
5TH NOV 77
27TH NOV 77
25TH OCT 77
25TH OCT 77

Mooring number : 140

Position of rig : LAT 53°43.0'n LONG 3°59.1'W (RIG C)

Depth of water : 39m below chart datum

Tidal heights, in metres above chart datum, at Hilbre Island :	MHWS	MHWN	MLWN	MLWS
	8.6	6.7	2.5	0.8

Meter	Type	Height above sea floor (m)	Recording interval (min)
0156	VACM	20	15
1749	Aanderaa RCM4	19	15

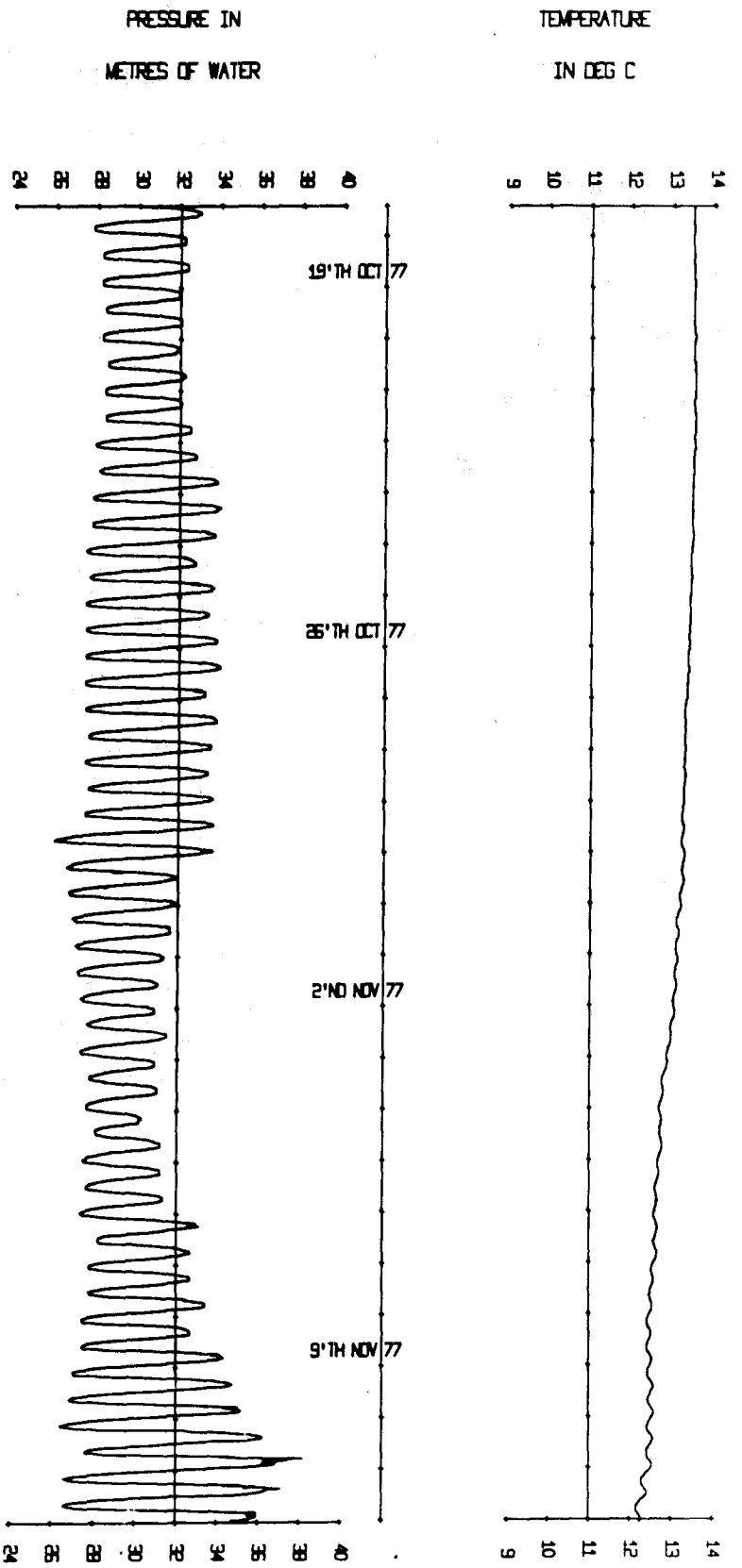
Rig set : 10.37 GMT 18 Oct 1977 from R.V. 'Prince Madog'

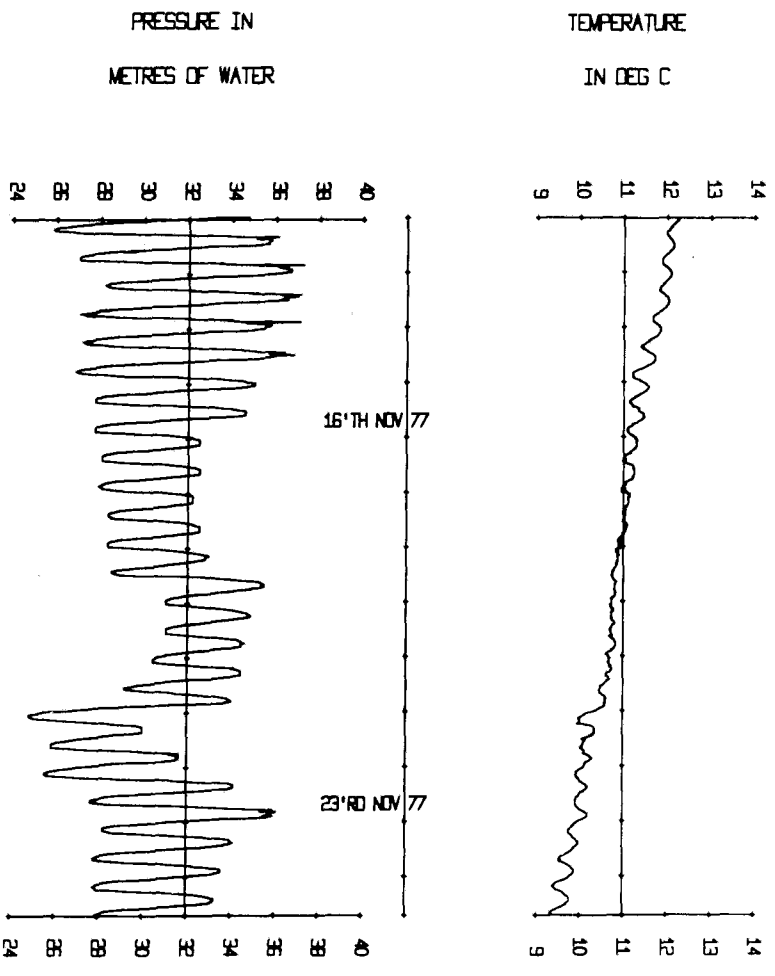
Rig recovered : 18.08 GMT 25 Nov 1977 from R.V. 'Prince Madog'

Mooring : Standard

Comments : The launch and recovery were successfully accomplished at the first attempt. The current meters came out of the water tangled with the anchor.

Meter	: Aanderaa 1749
Tape number	: 1749/5
Meter started	: 15.52.24 GMT 6 Oct 1977
Meter stopped	: 10.05.25 GMT 29 Nov 1977
Total number of readings	: 5162
Timing error	: 119s fast
Start of useful record	: -
End of useful record	: -
Length of useful record	: -
Comments	: The meter was fitted with a 0-200 PSI pressure sensor and a modified spindle. It was recovered without its rotor, acoustic transmitter and one stabiliser fin. The spindle was bent above the casting. The casting and spindle were polished as was one 'C' clamp. Its appearance suggested that the tangle had occurred before recovery. After 15 samples in the sea the rotor count becomes zero and the directions unusual. The pressure record shows that the meter was deployed 8m deeper than it should have been. Hence, the meter was either tangled with the ground-line or the meter wire. Only the temperature and pressure records are displayed from 10.53 18 Oct until 17.53 25 Nov.


PRESSURE IN
METRES OF WATER
TEMPERATURE
IN DEG C
19'TH OCT 77
26'TH OCT 77
2'ND NOV 77
9'TH NOV 77
24
26
28
30
32
34
36
38
40
9
10
11
12
13
14


PRESSURE IN
METRES OF WATER
TEMPERATURE
IN DEG C
24 26 28 30 32 34 36 38 40
9 10 11 12 13 14
16'TH NOV 77
23'RD NOV 77