I.O.S.

RRS DISCOVERY CRUISE 89

23 NOVEMBER - 20 DECEMBER 1977

PHYSICAL OCEANOGRAPHY AND CURRENT MEASUREMENTS IN THE N.E. ATLANTIC

Cruise Report No. 67

1978

NATURAL ENVIRONMENT RESEARCH COUNCIL

INSTITUTE OF OCEANOGRAPHIC SCIENCES

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LIST OF SCIENTIFIC PERSONNEL

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D. Edge	IOS (W)
W.J. Gould (Principal Scientist)	IOS (W)
*M.J. Harris	IOS (W)
N.W. Millard	IOS (W)
*G.R.J. Phillips	IOS (W)
*P.M. Saunders	IOS (W)
I. Waddington	IOS (W)
*R. Wallace	IOS (W)
*P. Hartland	IOS (Barry)
*C. Hazlehurst	IOS (Barry)
I. Innes	IOS (Barry)
J. Tranter	IOS (Bidston)

ITINERARY

Depart Barry	23 November 1977
Arrive Plymouth	18 December 1977
Arrive South Shields	20 December 1977

Personnel marked * left the ship in Plymouth.

OBJECTIVES OF THE CRUISE

(1) To recover and reset current meter moorings at nominal positions 46°N 17°W (NEADS Site 5)
41°N 25°W (NEADS Site 4)
42°N 14°W (NEADS Site 3).

(2) To set an additional current meter mooring at a site on the Azores-Biscay rise close to 41½°N 20°W.

(3) To test and incorporate in a current meter mooring a depth and tilt telemetering command pinger.

(4) To carry out extensive wire tests of acoustic release and command equipment.

(5) To deploy this acoustic equipment on a temporary mooring and to conduct acoustic ranging trials.

(6) To test and use a free fall acoustic profiler in order to determine vertical profiles of current velocity.

(7) To make tests of a sea surface, acoustically tracked float made from plastic components.

(8) To deploy T-7 (750 m depth) XBT probes at 40 km intervals on all passage legs.

NARRATIVE

Discovery sailed at 0600Z/23-XI-77 from Barry and in fresh south-westerly winds course was set for the first mooring position (NEADS Site 5 at 46°N 17°W). The PES fish was streamed at 1000Z. During the day the wind freshened to 40-50 kts and speed was reduced to 4 kts at times. Overnight there was a moderation and passage continued throughout the 24th with the scientific party preparing wire and buoyancy for the first mooring.

Echo sounding and XBT watches started at 2300Z/24th. Two lengths of braidline were tensioned and measured - the lengths agreeing with determinations made at Liphook (nominal 500 m lengths in fact measured 540 m). The XBT drops at 2100Z and 2300Z/25th gave bad traces which were thought to be due to earth leakage paths in the launcher which had been repaired at Barry prior to sailing. After

remaking the terminations the drops were resumed at 0500/26th.

The mooring site was reached at 0915Z/26th and the mooring recovered uneventfully by 1330Z. The hardware was in generally good condition after 9 months in the water. Wire tests were started on the units for the new mooring. The tests ended at 0400Z/27th and a brief PES survey was done to the SE of the mooring position. The ship was in position to start redeployment at 0800Z. The buoy was launched at 0836Z, the anchor released at 1126Z and the mooring bottomed out at 1228Z. After fixing the mooring position course was set for NEADS Site 4 (41°N 25°W). The XBT launcher failed again at 1700Z but repairs were effected by 2100Z. The launcher was generally in a very poor state.

The passage to NEADS Site 4 continued throughout 28th in 30-35 kts following winds. The mooring position was reached at 0700Z/29th. Both beacons were turned on by 0715Z and after two runs to fix the position the release was fired at 0807Z. The recovery was uneventful in spite of a bad tangle of the lowest 1000 m or so of the mooring line. The release mechanism was found to be badly corroded and could have released the mooring if the deployment had been much longer. The redeployment started at 1316Z and was completed by 1558Z and after two runs to position the mooring course was set towards the east to find a suitable position on the Azores-Biscay rise for an additional long term mooring.

Suitable topography was found by 1400Z/30th and after a brief E/S survey the mooring deployment was commenced at 1450Z. Due to previous damage to one of the 6 mm wire lengths the mooring design was changed so that synthetic rope was used throughout and glass balls were employed for the main buoyancy at 1500 m. The mooring was in place by 1638Z and after two runs to fix its position course was set towards NEADS Site 3 at 1714Z.

During December 1st the XBT launcher gave further trouble and was eventually dismantled completely. This showed the cause of the problem to be severe damage to the pins which make contact with the probe contacts. It was clear that the pins were unserviceable and new ones were made. The ship stopped at 1900Z/1-XII to do a wire test of release units for the next mooring. This test included a

pressure calibration for the pressure and tilt telemetering command beacon. All tests were successfully completed by 0132Z/2nd.

The mooring position was reached at 0700Z/2nd and the release fired at 0714Z. Again the recovery was uneventful being completed by 1035Z. Redeployment started at 1300Z and the anchor was released at 1600Z. The anchor reached the bottom at 1727Z. The depth of the pressure telemetering command beacon was monitored until 1900Z and after two positioning runs course was set for a suitable site away to the southwest where trials of the profiling float would be undertaken. The interrogator fish had been streamed while waiting for the mooring to settle.

On arrival at the profiling site a wire test was done of the remote interrogator for use in the profiler and on the successful completion of this an echo sounder survey of the site was started. This was continued until morning but severe weather (40-50 kts) prevented the first test. The sounding survey continued throughout December 3rd as weather and sea permitted. By the morning of the 4th the wind had moderated to 30 kts and the bottom beacons and profiler were launched. The profiler could not be heard on either of its frequency channels and so the beacons and profiler were recovered late in the afternoon in heavy weather and torrential rain.

The beacons and profiler were relaunched after modification of the profiler circuitry but with no improvement in performance.

Wire tests were done on the second remote interrogator and these continued into the morning of the 5th. The profiler and bottom beacons were recovered in bad weather by 1520Z/5th and echo sounding continued until a moderation permitted further wire tests of the second remote interrogator and of a normal float circuit modified to receive at 7.1 kHz and retransmit at 5.1 kHz. Both of these tests were successfully completed by 0240Z/6th.

Further echo sounding runs continued until the profiler with the newly modified circuit and the bottom transponders were launched. All appeared to be working well and after a determination of the baseline length the profiler was released at 1158Z/6th. The float was recovered by 1600Z. The profiler was relaunched at 1830Z with

the intention of releasing it from the bottom to be on the surface at first light 7th. A deterioration of conditions overnight precluded this and the vessel remained hove to in winds up to 60 kts until there was a moderation and the ship returned to the profiler release position. The profiler release was fired at 0720Z/8th and the profiler recovered at 1037Z.

Repairs of the XBT launcher had by then been completed and a test drop (Stn. 9702) was successful. The profiler was relaunched at 1318Z and reached the bottom at 1525Z. A CTD station (9703) was then worked to give a detailed sound velocity profile, on completion of this at 1905Z the ship ran out away from the profiler site so that acoustic wire tests could be carried out. These continued till 0730Z/9th when course was set back towards the profiler site. The profiler was released at 1109Z and recovered by 1410Z. The two bottom beacons were then released and these were both inboard by 1520Z.

A 4' diameter buoyancy sphere had meanwhile been prepared for an implosion test. The sphere was encased in a wire net, its possible leakage was monitored by a command beacon some 10 m above the sphere, a weight of approximately 3000 lbs was hung beneath the buoy. The sphere failed catastrophically at 990 m, the implosion being heard on the ship as was the bottom reflected arrival of the sound pulse.

Course was then set at 1704/9th towards the west where profiling was to be carried out at the new NEADS site (nominal $41\frac{1}{2}°$N 20°W) and a trial mooring laid for acoustic ranging tests. XBTs were launched on passage.

The site was reached by 0000Z/11th and a sounding survey carried out while waiting for suitable weather conditions for a final wire test of the acoustic gear. The test was started at 0515Z and completed at 0815Z. The test mooring was then deployed during the forenoon and ranging trials continued until 1845Z. Course was then set to find a suitable profiling position sufficiently far removed from both moorings. This was found and surveyed and the profiler and bottom beacons launched by 0010Z/12th. A CTD station was then worked and on completion of this the profiler was released at 0622Z. The profiler was recovered at 0913Z and the ship returned to the

trial mooring for further acoustic tests. These were completed by 1555Z and mooring recovery commenced. The subsurface buoyancy had come to the surface due to the stretch of the polypropylene line and the recovery line was badly tangled. In consequence the rubber dinghy was launched to facilitate the pickup. Recovery was completed by 1855Z and course set to the profiler site.

Overnight in calm weather trials were conducted of the new plastic surface float. Meanwhile the profiler was launched at 2351Z/12th, released from the bottom at 0600Z/13th and brought inboard at 0842Z. The bottom beacons were then recovered by 1010Z and after bringing the interrogator fish inboard course was set towards NEADS Site 5 with XBT stations on passage. In calm weather the ship was making 12 kts on 2 engines.

NEADS Site 5 was reached at 1100Z/14th and after an interrogation of the mooring a profiling site was selected to the NE of the mooring. Both beacons and the profiler were in position by 1530Z and after the determination of the base line the profiler was released at 1631Z. In good conditions the profiling float was picked up at 2021Z with the aid of the searchlight. A CTD station (9730) was then worked and on completion of this the profiler was relaunched at 2349Z/14th. The profiler was released from the bottom at 0652Z/15th and was inboard again at 1040Z. Another brief test of the plastic surface float was performed between 1058Z and 1251Z and the profiler launched at 1337Z. The release was fired in mid water (2300 m depth) at 1442Z and was recovered at 1633Z. The two bottom transponders were inboard by 1834Z/15th and course was set towards the U.K. with 2 hourly XBT profiles and echo sounding on passage.

At 0949Z/16th the vessel stopped to do a further wire test on some acoustic releases, to recover the interrogator fish, and to change the PES fish which had developed electrical noise overnight. This work was completed by 1150Z and passage was resumed. A tadpole body was towed for 2 hours at speeds of up to 11.5 kts with no apparent problems. PES and XBT watches ended at 0400Z/17th. The vessel anchored in Plymouth Sound 0900Z/18th and the majority of the scientific party disembarked. After repairs to the bridge radar the ship sailed for South Shields at 1320Z/18th arriving after a very foggy passage at 1500Z/20th.

MOORING WORK AND CURRENT METERS (Gould, Cherriman, Waddington)

The moorings recovered on this cruise were the longest duration full depth moorings yet attempted by IOS. There were no problems associated with the mooring recoveries and for the most part there was little corrosion on either the mooring line, instruments or release equipment.

Details of the moorings recovered and relaid are given below together with comments on instrument performance.

Mooring number: 226 (Discovery Stn 9417), NEADS Site 5.
Date/time set: 1844Z/27-II-77(56). Recovered: 0947Z/26-XI-77(330).
Position: 46°04.6'N 17°10.7'W. Depth: 4760 m.
Current records

22601 (600 m nominal). 152 days of good data. Record curtailed by clock battery failure.

22602 (1500 m nominal). 214 days of good data then noisy rotor channel. Data thereafter may be recoverable by editing.

22603 (3000 m nominal). 274 days of good data.

22604 (4000 m nominal). 21 days of good data. Main battery failure causes large loss of data.

Hardware

One glass ball broken on recovery.

Mooring number: 227 (Discovery Stn 9472), NEADS Site 4.
Date/time set: 1646Z/5-III-77(64). Recovered: 0807Z/29-XI-77(333).
Position: 41°00.9'N 24°52.5'W. Depth: 3609 m.
Current records

22701 (600 m nominal). 93 days good data. Clock battery failure.

22702 (1500 m nominal). Probably a full length record but data need extensive editing.

22703 (3000 m nominal). Full length record. Some direction problems after 120 days which became more severe after 160 days.

22704 (3500 m nominal). Full length record. Good data throughout.

Hardware

Bottom end of mooring came up in a big tangle. Glass balls were looped around bottom two current meters. No damage sustained. Quite severe corrosion on acoustic release mechanism.

Mooring number: 228 (Discovery Stn 9493), NEADS Site 3.
Date/time set: 1223Z/9-III-77(68). Recovered: 0714Z/2-XII-77(336).
Position: 41°55.0'N 14°08.2'W. Depth: 5325 m.
Current records

22801 (600 m nominal). 61 days of record. Stopped due to failure of main battery. Patch of bad data lasting for 6 days and starting 38 days into the record. Apparently due to an encoder fault.

22802 (1500 m nominal). Only 18 days of good data. Main battery failure.

22803 (3000 m nominal). Only 44 days of good data. Main battery failure.

22804 (4000 m nominal). Full record. All good data.

Mooring number: 239 (Discovery Stn 9656), NEADS Site 5.
Date/time set: 1228Z/27-XI-77(331).
Position: 46°03.1'N 17°07.7'W. Depth: 4752 m.

Mooring number: 240 (Discovery Stn 9678), NEADS Site 4.
Date/time set: 1609Z/29-XI-77(333).
Position: 41°01.0'N 24°48.9'W. Depth: 3668 m.

Mooring number: 241 (Discovery Stn 9690), NEADS Site $3\frac{1}{2}$.
Date/time set: 1638Z/30-XI-77(334).
Position: 41°41.7'N 20°13.4'W. Depth: 3677 m.

Mooring number: 242 (Discovery Stn 9701), NEADS Site 4.
Date/time set: 1726Z/2-XII-77(336).
Position: 41°54.1'N 14°06.0'W (anchor drop position).
Depth: 5325 m.

Mooring number: 243 (Discovery Stn 9715), Acoustic test mooring.
Date/time set: 1230Z/11-XII-77(345).
Position: 41°25.3'N 19°37.1'W (anchor drop position).
Depth: 4748 m.

FLOAT TRACKING (PROFILING) (Saunders, Gould, Millard)

Current profiling was undertaken on this cruise at three sites widely separated from one another but each in the vicinity of a current meter mooring. In brief the measurement required two transponders to be moored close to the sea bed with a separation (3-4 km) measured acoustically. A third transponder (the profiling float) was then allowed to rise slowly from the bottom to the surface (or vice versa); its position and depth was determined periodically and from its displacement currents averaged over depth determined. The profiling float navigation was performed by measuring acoustic travel times between the ship and the bottom transponders and between the ship and the profiling float, and by an ingenious ring-around technique also between the bottom transponders and the profiling float. To convert travel times to slant ranges contemporary CTD casts were made at each site and sound velocity profiles computed.

Current profiling was first attempted in this way on Discovery Cruise 81 in the same area of the North Atlantic in January/February 1977 but due to technical problems was abandoned. Amongst the improvements which contributed to the success of our measurements on this cruise must be mentioned (1) the introduction of slow wave guides into the bottom transponder transducer to improve vertical directivity (2) the orientation of the profiling float transducer axis 45° from the vertical (3) simplification of the profiler float electronics from two channel reception to single channel reception (4) simultaneous display of four signals on the Mufax recorder and (5) less frequent interrogations from the ship, allowing multiple path echoes to die out before the next transmission.

The bottom transponders moorings were arranged as follows:- two 16" diameter Corning glass spheres in hard hats bolted to a simple steel frame, 50 m of 6 mm diameter polypropylene rope, the 2 m long bottom transponder with pyro-releases, 50 m of 6 mm diameter polypropylene rope, 100-150 lb chain link anchor. The mooring was paid

over the stern by hand whilst underway at about 1 kt, buoyancy spheres first and when entirely laid out the chain anchor was kicked overboard: its descent rate was about 90 m/min. When the 4 m long profiling float was launched with the bottom transponder it was connected by 20 m of the same polypropylene rope above the buoyancy spheres, and hence was the first item over. When deployed from the ship alone, the profiling float had between 5 m and 20 m polypropylene rope between its pyro-release and the 2 kg external weight: descent and ascent rates of this float were close to 30 m/min.

Once we had established that all the travel times required for the profiling float navigation could be measured from the ship, our strategy was to make a time series of profile measurements spaced approximately 6 hours apart. Such measurements should enable us to determine the magnitude of the semidiurnal tidal signal in our data. Because of interruptions from bad weather and a reluctance to recover the profiling float after dark a complete set of such data was only obtained at one site (site 3).

The details of the bottom transponder deployments and recoveries and profiling float deployments and recoveries and the data gathering periods are shown in the accompanying table.

Profiling Float Measurements

Site 1 Near 41°45'N, 14°47'W (all times GMT).

Beacon 1 Chan 12 over 1011, 4-12-77, released 1411, back 1520, 9-12-77, water depth 5325 m.

Beacon 2* Chan 7 + Chan 0 over 0813, 6-12-77, released 1340, back 1448, 9-12-77, water depth 5329 m. Separation 3000 m, orientation 030°.

Profiling float 1 UP 1158-1420, 6-12-77, back 1556, 0 hours elapsed.

2 DOWN 1830-2050, 6-12-77, - 6 hours elapsed.

3 UP 0720-1015, 8-12-77, back 1037, 43 hours elapsed.

4 DOWN 1318-1525, 8-12-77, - 49 hours elapsed.

*Two deployments and two recoveries made prior to the successful third.

5 UP 1109-1335, 9-12-77, back 1410,
71 hours elapsed.

CTD cast (station 9703) made 1606-1901, 8-12-77; cast depth 4000 m, bottom depth 5323 m. Down at 17[illegible] position 41°45.9'N, 14°49.3'W.

Site 2 Near 41°35'N, 19°48'W.

Beacon 1 Chan 7 + Chan 0 over 2337, 11-12-77, released 0843, back 0940, 13-12-77, water depth 3933 m.

Beacon 2 Chan 12 over 0010, 12-12-77, released 0842, back 1010, 13-12-77, water depth 3854 m.
Separation 4100 m, orientation 00°.

Profiling float 6 UP 0622-0830, 12-12-77, back 0913, 0 hrs.
7 DOWN 2351-0110, 13-12-77, 18 hrs.
8 UP 0600-0815, 13-12-77, back 0842, 24 hrs.

CTD cast (station 9716) made 0245-0502, 12-12-77; cast depth 3700 m, bottom depth 3785 m. Down at 0351, position 41°36.3'N, 19°54.5'W.

Site 3 Near 46°06'N, 17°02'W.

Beacon 1 Chan 17 over 1314, 14-12-77, released 1639, back 1834, 15-12-77, water depth 4738 m. 2513 uncorr. fthms.

Beacon 2 Chan 7 + Chan 0 over 1418, 14-12-77, released 1638, back 1748, 15-12-77, water depth 4742 m. 2515 uncorr. fthms.
Separation 4210 m, orientation 00°.

Profiling float 9 UP 1631-1910, 14-12-77, back 2021, 0 hrs.
10 DOWN 2349-0125, 15-12-77, 7 hrs.
11 UP 0652-0930, 15-12-77, back 1040, 14 hrs.
12 DOWN 1337-1442, 15-12-77, to 2300 m only, 21 hrs.
13 UP 1442-1615, 15-12-77, back 1633, 22 hrs.

CTD cast (station 9730) made 2103-2258, 14-12-77; cast depth 4000 m, bottom depth 4717 m. Down at 2204, position 46°08.0'N, 17°01.9'W.

Experimental surface float (plastic) deployments

Site 2 Away 2158, 12-12-77, back 0250, 13-12-77.

Site 3 Away 1058, 15-12-77, back 1251, 15-12-77.

XBT SECTIONS (Gould)

XBT data were collected at two hourly intervals on all passage legs using T-7 (850 m) probes. Considerable problems were encountered with the XBT launcher which was eventually discovered to have broken contact pins which were causing leakage paths to earth. All stations were accompanied by surface salinity and temperature determinations from bucket samples. Details of the XBT data available may be found from the station list. All data were radioed to Bracknell in accordance with IGOSS Bathy observation procedures.

MOORING ACOUSTICS (Harris, Phillips)

All of the acoustic releases and beacons on moorings 226, 227 and 228 operated correctly during their recovery. There was no evidence to suggest that the performance of the electronics of these units had altered in any way. The aluminium hardware was still in good condition apart from some minor pitting on the stems of two of the acoustic transducers. The majority of the stainless steel was in good condition except for some of the tube clamps which were corroded where the clamps had come into contact with the insulation rubbers, and one side plate of each of the pyro release holders. One of these plates was completely eaten away in two places and would probably have released the mooring in another 2 or 3 months. As this stainless steel was from the new certified stock, I would suggest that our existing test procedure is still not stringent enough.

Four sets of acoustic releases and commands were satisfactorily wire tested to a depth of 5000 m prior to being laid on moorings 239, 240, 241 and 242. The command beacon on mooring number 239 was successfully interrogated again at the end of the cruise. The command beacon (CB 205) on mooring number 242 was an experimental depth/tilt telemeter. The depth sensor and tilt indicators on this beacon provided useful information concerning the performance of the mooring while it was being laid.

Four different types of experimental command beacon were assembled and 'wire tested' prior to being used on an experimental mooring.

These beacons were:

(a) Command beacon (CB 201) fitted with an ITC 2003 ceramic ring transducer instead of standard 10 kHz mushroom transducer,

(b) Depth/tilt command beacon (CB 206) containing an additional electronics card for converting the pressure frequency signal to a time delayed pulse. This pressure signal was obtained from a pressure sensor and associated electronics housed in a separate tube. It also transmitted additional pulses giving an indication of the attitude of the unit in the water,

(c) Multiple command beacon (CB 301) was a new type of command system employing the standard technique for signal discrimination but with a new signal processing system. This particular unit was arranged to provide three discrete switching functions and a transponding mode as well as the standard beacon mode. In the transponding mode the carrier frequency of the pulse was 10.6 kHz instead of the standard 10 kHz,

(d) Multiple command beacon (CB 300) was similar to (c) but had a 10 kHz ceramic ring transducer fitted instead of the standard 'mushroom' transducer.

All of these new units operated correctly when wire tested but it was not possible to switch in the three coded switches on CB 300. At the time this was attributed to the narrowness of bandwidth on one of the filters used to decode the FM signal received by the unit. This unit was then modified in an attempt to correct this fault. A further wire test of this unit showed that there was an additional problem on the signal processing logic.

These units were placed in an experimental mooring as shown in Figure 1. This mooring was set in a water depth of 4750 m at 41°25'N and 19°37'W on 11th December, day 345. This mooring was laid to enable acoustic range trials to be made to check the following:

(a) The transmitting and receiving sensitivity of the acoustic transducers on the mooring. Originally it was planned to place mushroom and ceramic ring transducers near to the surface and near to the sea bed. However, earlier wire tests indicated that the

ceramic ring had insufficient sensitivity to operate correctly at 4700 m. In view of this the command units were deployed as shown in Fig. 1,

(b) The operational sensitivity of the command units on the mooring,

(c) The transmitting and receiving sensitivity of three different types of transducer used with the shipboard system. These transducers were:

(i) a single element of the PES fish
(ii) a mushroom transducer mounted in a 'Dolphin' (a light weight towed vehicle)
(iii) a ceramic ring transducer mounted in a Dolphin.

These transducers were deployed as shown in Fig. 2.

The first of the two acoustic range trials took place on the same day the mooring was laid. Acoustic measurements were taken while the ship was moving away from the mooring on a course of 045° and speed over the ground of 1.5 knots. Initially the ship and sea noise was severe making it difficult to obtain the required measurements. Fortunately towards the end of the run the weather moderated and the acoustic conditions improved. The second range trial took place on 12th December (day 346). On this occasion the measurements were taken while the ship moved in to the mooring position from a horizontal range of 6 miles. The ship's average speed over the ground was 2 knots and the course was 135°. On completion of this run the experimental mooring was released and recovered. All of the instruments on the experimental mooring operated correctly, apart from the multiple command mode on CB 300.

A further examination of the multiple command CB 300 revealed an electronic wiring fault. This was corrected, and on 16th December (day 350) CB 300 was 'wire tested' at a depth of 2.5 km. On this occasion all the functions of the multiple command operated correctly.

An initial investigation of the data obtained from this work confirms the opinion that it is preferable to use a mushroom transducer on the acoustic commands for deep operation and a ceramic ring for shallow operation.

The performance of the ITC ceramic ring was better than expected as operational ranges of 2 km were obtained. Comparison of the ship-board transducers proved the PES element to be better for deep water work while the ring was the better transducer for work in shallow water. The mushroom, because of its relatively narrow beam angle, was more susceptible to signal loss due to the porpoising of the towed vehicle. For this reason it was not as suitable as the single element with which it was compared. The 'Dolphins' were towed at various speeds up to 4 knots and performed well both in head and beam seas, thus proving that they were suitable for use with the acoustic command system.

It is felt that sufficient data has been obtained from this cruise to significantly improve our understanding of the performance of the equipment that was tested.

COMPUTER GROUP REPORT (Hazlehurst, Hartland, Innes)

IBM 1800 System

Routine data logging activities were carried out. The principal interest was in corrected navigation, with live track plots being provided as requested. Daily track charts were plotted, and detailed bathymetric charts of some survey areas were also produced. These operations were performed relatively smoothly, and only occasional operator intervention was necessary.

A few modifications were made in order to reduce the number of system crashes associated with the use of the Tally line printer and the two Alpha-Numeric Terminals.

PDP 11/04 System

The main interest in this system was in the development of a CTD sampling program linked to the 1800 system to make use of the CTD processing programs available on the 1800. The link was successfully made and the program developed as far as possible.

The 11/04 system was also used to develop interfaces for the proposed Batfish/CTD sampling system based on the 11/34.

The bootstrap loader and an absolute loader were written to enable the DEC supplied diagnostic programs to be loaded from paper-tape via CAMAC.

STATION LIST

Stn. No.	Date	Time(Z)	Lat. N	Long. W	Observation	Comments
9642	25-XI	0059	48°33.2'	10°54.0'	XBT	
9643	25-XI	0300	48°22.1'	11°22.2'	XBT	
9644	25-XI	0500	48°11.4'	11°50.3'	XBT	
9645	25-XI	0648	48°01.6'	12°15.7'	XBT	
9646	25-XI	0857	47°49.3'	12°45.2'	XBT	
9647	25-XI	1058	47°38.6'	13°12.2'	XBT	
9648	25-XI	1300	47°28.2'	13°38.2'	XBT	
9649	25-XI	1500	47°18.3'	14°04.3'	XBT	
9650	25-XI	1857	47°07.5'	14°31.2'	XBT	
9651	25-XI	2100			XBT (Bad trace)	
	25-XI	2104			XBT (Bad trace)	
	25-XI	2112	46°58.8'	14°56.9'	XBT	
9652	25-XI	2300			XBT (Bad trace)	
	25-XI	2316	46°51.7'	15°20.1'	XBT (Bad trace)	Launcher dismantled
9653	26-XI	0441	46°28.6'	16°11.6'	XBT	
9654	26-XI	0700	46°16.8'	16°40.6'	XBT	
9655	26-XI	0900	46°06.4'	17°05.0'	XBT	
9417	26-XI	0910-1302	46°04.6'	17°10.7'	Recovery Mooring 226	NEADS Site 5
9656	27-XI	0800-1300	46°03.1'	17°07.7'	Setting Mooring 239	NEADS Site 5
9657	27-XI	1304	46°03.3'	17°07.2'	XBT	
9658	27-XI	1500	45°51.0'	17°26.7'	XBT	
9659	27-XI	1658	45°39.2'	17°49.7'	XBT (Bad trace)	
9660	27-XI	2054	45°12.2'	18°32.2'	XBT	
9661	27-XI	2257	44°57.0'	18°54.8'	XBT	
9662	28-XI	0100	44°44.7'	19°14.9'	XBT (Bad trace)	
9663	28-XI	0300	44°30.2'	19°37.3'	XBT	
9664	28-XI	0500	44°15.1'	19°59.7'	XBT	
9665	28-XI	0700	43°59.8'	20°22.3'	XBT	
9666	28-XI	0900	43°45.7'	20°44.8'	XBT	
9667	28-XI	1059	43°31.9'	21°08.6'	XBT	

Stn. No.	Date	Time(Z)	Lat. N	Long. W	Observation	Comments
9668	28-XI	1256	43°18.4'	21°31.2'	XBT (Two tries)	
9669	28-XI	1500	43°04.0'	21°55.3'	XBT	
9670	28-XI	1700	42°48.9'	22°16.9'	XBT	
9671	28-XI	1900	42°34.0'	22°38.8'	XBT	
9672	28-XI	2102	42°19.0'	23°01.3'	XBT	
9673	28-XI	2300	42°04.0'	23°24.1'	XBT	
9674	29-XI	0100	41°48.7'	23°46.7'	XBT	
9675	29-XI	0300	41°33.3'	24°07.5'	XBT	
9676	29-XI	0500	41°18.3'	24°28.8'	XBT	
9677	29-XI	0658	41°02.5'	24°48.2'	XBT	
9472	29-XI	0714-1040	41°00.9'	24°52.5'	Recovery Mooring 227	NEADS Site 4
9678	29-XI	1300-1646	41°01.0'	24°48.9'	Setting Mooring 240	NEADS Site 4
9679	29-XI	1704	41°01.0'	24°44.9'	XBT (Two tries)	
9680	29-XI	1900	41°04.1'	24°19.8'	XBT	
9681	29-XI	2100	41°08.0'	23°53.6'	XBT	
9682	29-XI	2259	41°11.9'	23°27.5'	XBT	
9683	30-XI	0100	41°15.6'	23°01.0'	XBT (Two tries)	
9684	30-XI	0300	41°18.9'	22°35.3'	XBT	
9685	30-XI	0500	41°22.3'	22°08.7'	XBT (Two tries)	
9686	30-XI	0700	41°25.6'	21°42.9'	XBT	
9687	30-XI	0859	41°29.6'	21°17.1'	XBT	
9688	30-XI	1100			XBT (Failed)	
		1104	41°34.3'	20°50.8'	XBT	
9689	30-XI	1300	41°38.6'	20°27.0'	XBT	
9690	30-XI	1400-1714	41°41.7'	20°13.4'	Setting Mooring 241	NEADS Site $3\frac{1}{2}$
9691	30-XI	2059			XBT (Failed)	
		2102			XBT (Failed)	
		2106	41°39.5'	20°08.8'	XBT	
9692	30-XI	2300	41°40.7'	19°45.2'	XBT	

Stn. No.	Date	Time(Z)	Lat. N	Long. W	Observation	Comments
9693	1-XII	0100	41°43.0'	19°18.2'	XBT (Two tries)	
9694	1-XII	0300	41°42.8'	18°53.0'	XBT	
9695	1-XII	0457	41°43.0'	18°28.8'	XBT (Poor trace)	
9696	1-XII	0706	41°44.6'	18°02.3'	XBT	
9697	1-XII	0900	41°47.0'	17°38.4'	XBT	
9698	1-XII	1100	41°48.0'	17°11.8'	XBT	
9699	1-XII	1617	41°51.0'	16°01.0'	XBT	
9700	1-XII	1700	41°51.8'	15°50.7'	XBT	Launcher failed on next attempt at 1900Z.
9493	2-XII	0652-1035	41°55.0'	14°08.2'	Recovery mooring 228	NEADS Site 3
9701	2-XII	1230-1920	41°54.1'	14°06.0'	Setting mooring 242	NEADS Site 3
9702	8-XII	1040	41°43.2'	14°45.9'	XBT	
9703	8-XII	1606-1901	41°45.9'	14°49.3'	CTD (4000 m)	
9704	9-XII	1900	41°44.3'	15°04.9'	XBT	
9705	9-XII	2100	41°43.3'	15°25.9'	XBT	
9706	9-XII	2300	41°42.2'	15°48.5'	XBT	
9707	10-XII	0100	41°42.1'	16°12.3'	XBT	
9708	10-XII	0300	41°43.0'	16°36.4'	XBT	
9709	10-XII	0500	41°43.8'	17°00.1'	XBT (Two tries)	
9710	10-XII	0700	41°43.8'	17°17.0'	XBT	
9711	10-XII	0900	41°43.2'	17°32.8'	XBT	
9712	10-XII	1100	41°42.7'	17°49.0'	XBT (Failed) (3 tries)	
9713	10-XII	1300	41°42.4'	18°02.4'	XBT (Two tries)	
9714	10-XII	1500	41°42.0'	18°20.3'	XBT (Poor)	
9715	11-XII	0848-1146	41°25.3'	19°37.1'	Setting mooring 243	Acoustic trials
9715	12-XII	1600-1955	41°25.3'	19°37.1'	Recovery mooring 243	Acoustic trials
9716	12-XII	0245-0502	41°36.3'	19°54.5'	CTD (3700 m)	

Stn. No.	Date	Time(Z)	Lat. N	Long. W	Observation	Comments
9717	13-XII	1100			XBT (Failed)	
	13-XII	1103	41°41.2'	19°49.2'	XBT	
9718	13-XII	1300	42°00.6'	19°38.5'	XBT	
9719	13-XII	1500	42°22.2'	19°24.8'	XBT	
9720	13-XII	1700	42°45.0'	19°12.0'	XBT	
9721	13-XII	1900	43°07.7'	18°57.5'	XBT	
9722	13-XII	2058	43°28.2'	18°43.5'	XBT	
9723	13-XII	2305	43°49.6'	18°30.6'	XBT	
9724	14-XII	0100	44°09.2'	18°18.2'	XBT	
9725	14-XII	0300	44°29.8'	18°07.2'	XBT	
9726	14-XII	0500	44°50.6'	17°55.0'	XBT	
9727	14-XII	0700	45°11.8'	17°42.6'	XBT	
9728	14-XII	0900	45°33.7'	17°28.7'	XBT	
9729	14-XII	1100	45°55.3'	17°14.1'	XBT	
9730	14-XII	2103-2258	46°08.0'	17°01.9'	CTD (4000 m)	
9731	15-XII	1900	46°08.1'	17°00.1'	XBT	
9732	15-XII	2100	46°16.8'	16°32.2'	XBT	
9733	15-XII	2258	46°25.0'	16°05.6'	XBT	
9734	16-XII	0100	46°32.7'	15°39.0'	XBT	
9735	16-XII	0300	46°41.8'	15°12.0'	XBT	
9736	16-XII	0500	46°50.3'	14°45.6'	XBT	
9737	16-XII	0700	46°59.2'	14°20.1'	XBT	
9738	16-XII	0900	47°07.9'	13°54.2'	XBT	
9739	16-XII	1300	47°15.9'	13°28.2'	XBT	
9740	16-XII	1500	47°23.1'	13°04.3'	XBT (Two tries)	
9741	16-XII	1700	47°32.6'	12°37.9'	XBT	
9742	16-XII	1900	47°41.6'	12°10.2'	XBT (Two tries)	
9743	16-XII	2100	47°50.3'	11°42.6'	XBT	
9744	16-XII	2300	47°58.8'	11°15.1'	XBT	
9745	17-XII	0100	48°07.3'	10°47.2'	XBT	
9746	17-XII	0300	48°15.6'	10°18.4'	XBT	

Fig. 1

EXPERIMENTAL MOORING

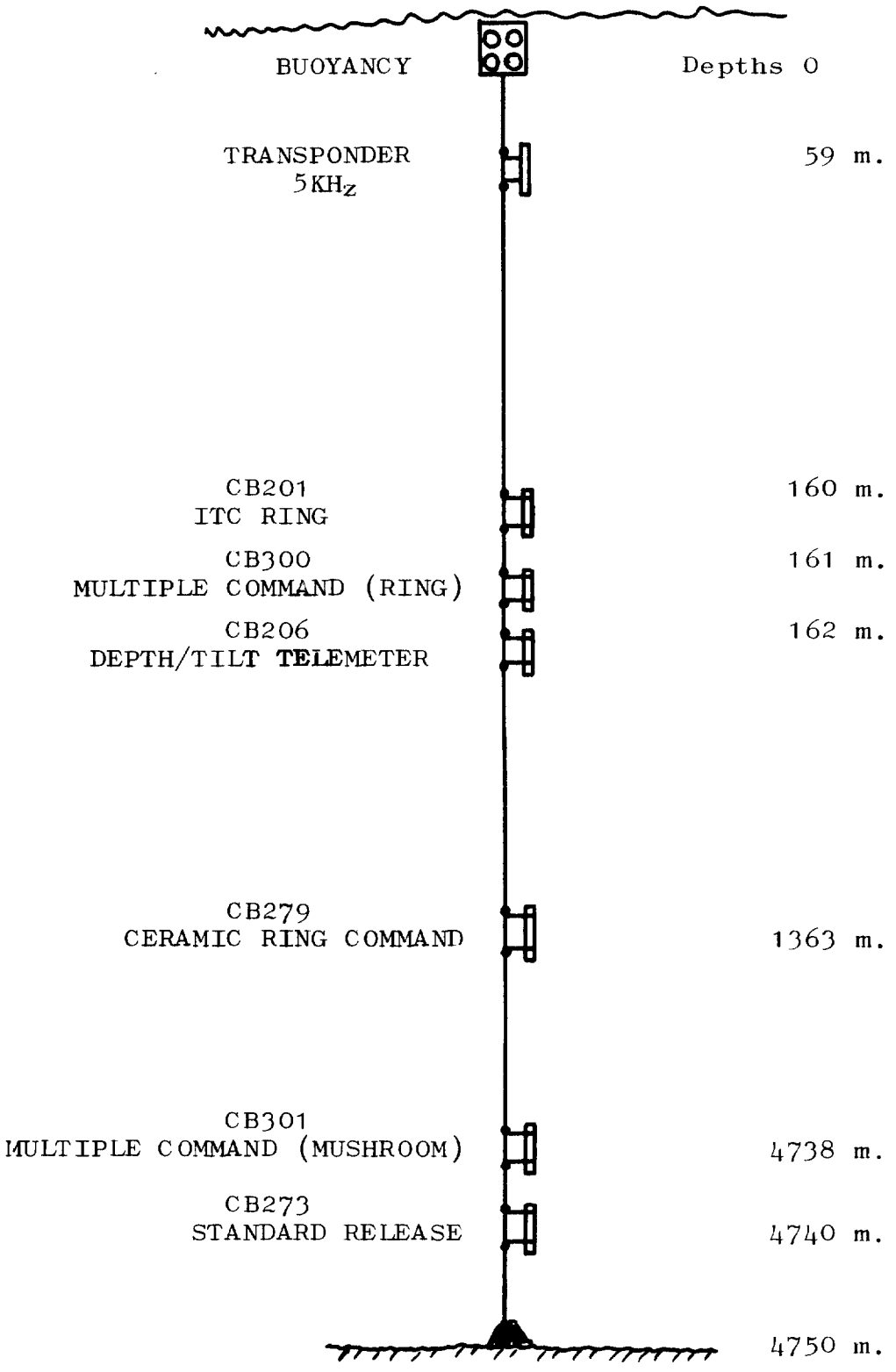
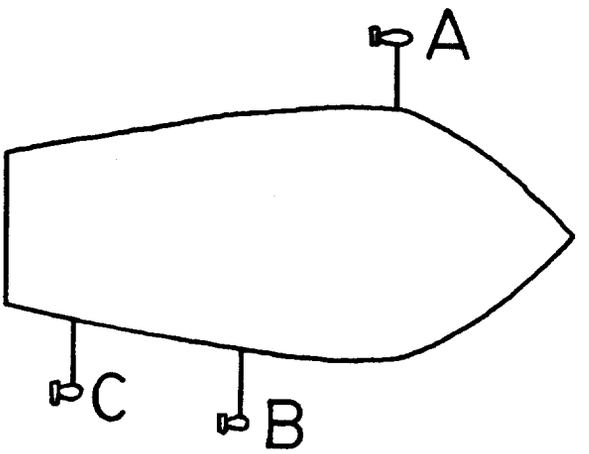
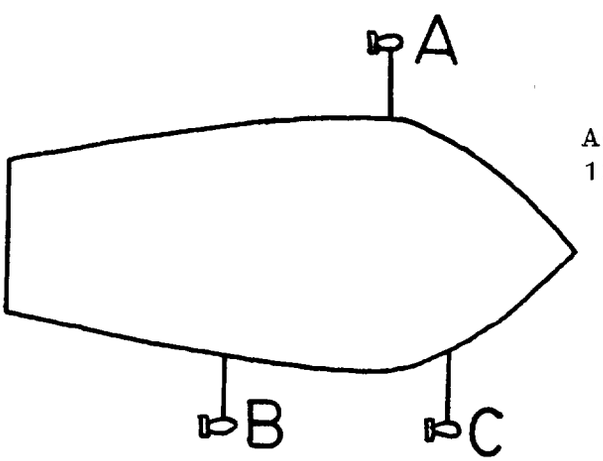


Fig. 2

DEPLOYMENT OF SHIPBOARD ACOUSTIC TRANSDUCERS.



As used on
11.XII.77 (Day 345)



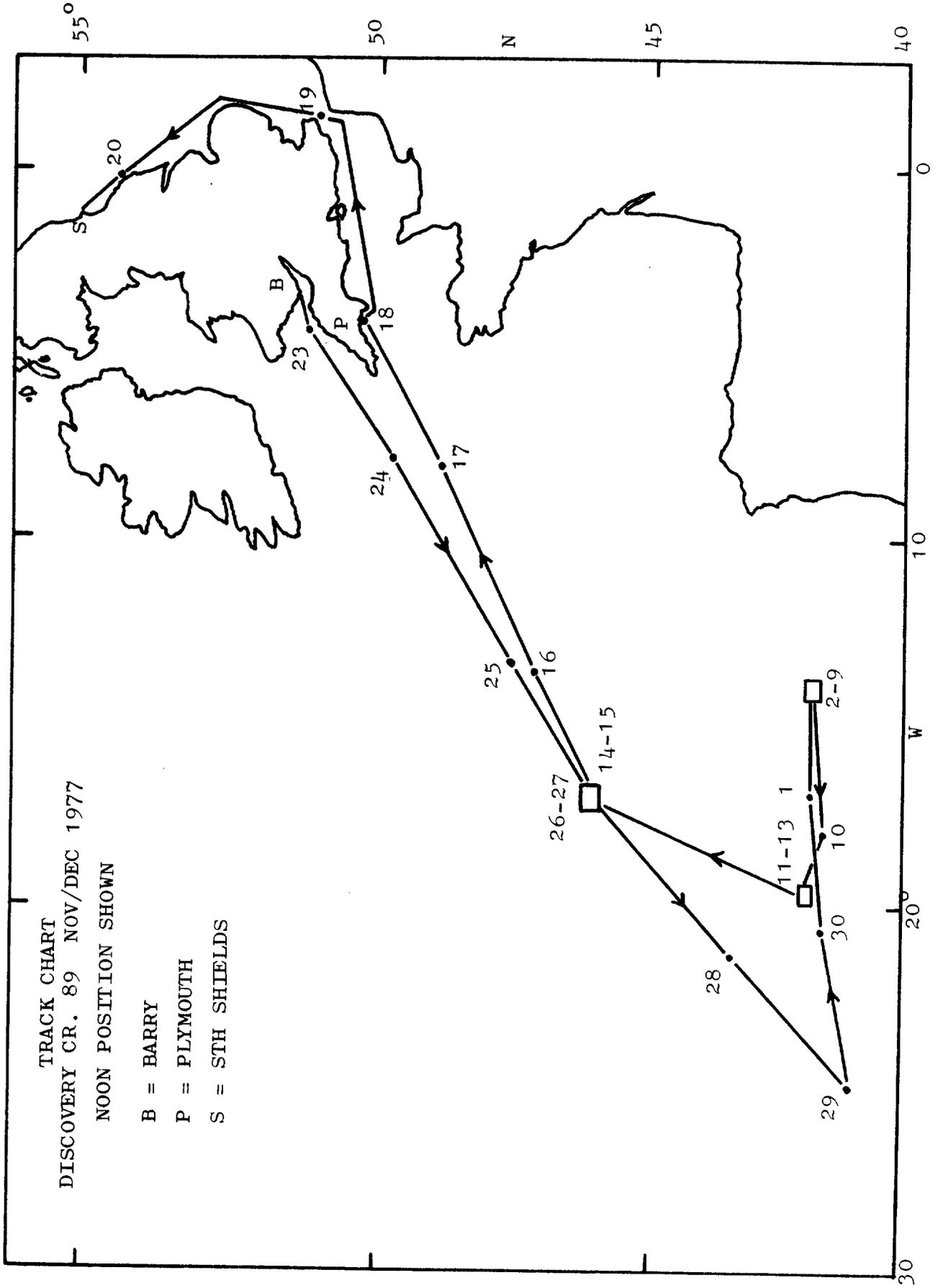
As used on
12.XII.77 (Day 346)

A. SINGLE ELEMENT OF PES FISH

B. CERAMIC RING DOLPHIN

C. MUSHROOM DOLPHIN

Fig. 3


TRACK CHART
DISCOVERY CR. 89 NOV/DEC 1977
NOON POSITION SHOWN
B = BARRY
P = PLYMOUTH
S = STH SHIELDS
55°
50
45
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N
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16
26-27
14-15
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11-13
1
2-9
10
30

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69	JAN - MAR 1975	51
73	JUL - AUG 1975	34
74/1+3	SEP - OCT 1975	35
74/2		33
75	OCT - NOV 1975	43
77	JUL - AUG 1976	46
78	SEP - OCT 1976	52
79	OCT - NOV 1976	54
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83	MAY - JUN 1977	61
84	JUN - JUL 1977	60
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87	OCT 1977	58

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