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INTERNAL DOCUMENT 36

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West of Shetland Data Buoy Project
Fourth Report

September 1977 to April 1978

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NATURAL ENVIRONMENT RESEARCH COUNCIL
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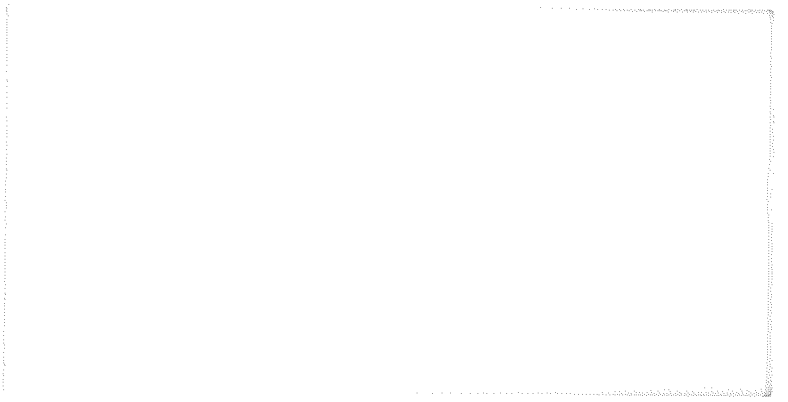

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West of Shetland Data Buoy Project
Fourth Report

September 1977 to April 1978

Internal Document No 36

Institute of Oceanographic Sciences
Crossway
Taunton
Somerset

August 1978

Report from the Institute of Oceanographic Sciences to the United Kingdom Offshore Operators Association on the conduct of the West of Shetland data buoy project from 24 September 1977 to 1 April 1978

Issued by:

Institute of Oceanographic Sciences
Crossway
Taunton
Somerset

August 1978

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TABLE 1 West of Shetland Data buoy Project - Summary table: September 1977 - April 1978

Date		Events	Marex Buoy		Waverider	Foula Station
September 1977	17/18	Service visit to buoy: production processor replaced	17/18	No data: production processor faulty. Service visit		Data recorded from Marex buoy but radio signals getting progressively weaker.
	28	Project meeting to discuss data processing		No data: leak in processor module case	Not deployed	
October 1977	16	UKOOA authorised redeployment of Waverider				17 Last usable record.
	23/26	IOS party visited Foula, wind generator installed.				Buoy signal received intermittently
November 1977	4	Service visit to buoy	4			
	9	IOS informed Marex that buoy radio transmission no longer being received on Foula		No data: cause not yet known		9 Buoy signal lost
	16	Supply boat confirmed buoy not on station				No signals
	25	Waverider deployed			25	
	28	IOS informed of deployment			Waverider operating	28 Reception of Wave-rider commenced
December 1977	14	Data buoy found adrift by MV Gorm Viking	14			
	23	Attempt to redeploy buoy abandoned owing to bad weather		No buoy deployed		Waverider data recorded
Jan 1978	19	Marex data buoy 02 deployed IOS service visit to Foula	19		Signals becoming weak	19 Digital recorder faulty. Analogue data from Waverider record becoming intermittent as signal weakened.
	3	Buoy run down and dismasted		Partial data		
	7	IOS informed Marex that buoy signal not being received and Waverider weak				
February 1978	10	Service visit to buoy. Buoy on station but had been run down. Towed into Scalloway for repairs. Waverider checked and redeployed. Project meeting at Cowes	10	No buoy deployed		

(continued over)

Date	Events	Marex Buoy	Waverider	Foula Station
March 1978				
1	Deployment attempt abandoned - deployment vessel U/S, and weather deteriorating.	No buoy deployed		
18	Deployment attempt abandoned - deployment vessel U/S			
28				Digital recorder operating correctly
April 1978				
1	Marex data buoy deployed, Waverider not serviced because of deteriorating conditions	1		

INTRODUCTION

This is the fourth in a series of reports on the conduct of the UKOOA West of Shetland data buoy project. It covers the six months or so from 24 September 1977 to 1 April 1978.

The organisational aspects of the project have remained the same, ie the Natural Environment Research Council, Institute of Oceanographic Sciences, has contracted with UKOOA to make measurements to the West of Shetland and UKOOA have nominated Marine Exploration Ltd (Marex) as the major subcontractor, to be responsible for the supply and operation of a data buoy.

A brief description of the project is again included as an Appendix.

The third report in this series documented a sharp deterioration in the performance of the buoy system and a special report was prepared by IOS (Ref 1) giving details of the causes of failure, and proposals for action to improve the performance in future. That report covered the period until 4 December 1977. Events after 24 September which have been discussed in that report will also be briefly described in the present report.

Once again many difficulties and setbacks have had to be faced.

Scope and organisation of the Report

The narrative is divided into parts dealing respectively with the Marex operation and the receiving station on Foula. The data from both sources are considered separately.

Part 1 is preceded by a table which summarises in chronological order the main events which occurred during the period (Table 1).

Appendix A – Brief description of the project (reproduced from the first report)

Appendix B – Data return of the project as a whole from 9 November 1977 to 12 July 197

Appendix C – Description of IOS checking procedure.

PART 1 - The Marex Operation

A service visit was made on 17/18 September 1977 (see Third Report in this series and Ref 1), at which time the production processor was replaced by the prototype. Subsequent analysis showed that no data had been recorded by the production processor due to a design fault which had unfortunately remained hidden during testing.

The next service visit took place on 4 November and once again subsequent analysis showed that no usable data had been recorded, on this occasion because of a leak in the processor module case.

During the latter part of September and October the transmissions from the data buoy had again become very weak, and Marex had intended to replace several components on the buoy in an attempt to restore transmission to an adequate level. However due to deteriorating weather conditions this could not be done on the 4 November service visit.

On 9 November our agent on Foula informed IOS that the buoy signal was no longer being received, and IOS immediately informed Marex.

On 16 November a search sweep of the deployment position was made at Marex's request by a supply vessel servicing the drilling rig Atlantic I operating nearby. The data buoy was not seen.

On 25 November at 1649 GMT the back-up Waverider was redeployed from the supply vessel Staid Scotsman servicing the rig Atlantic I. The data buoy was not sighted on this occasion. Deployment details were:

Time:	1649 GMT	Date:	25 November 1977
Position:	$60^{\circ}08'N$; $2^{\circ}59'W$		
Wind:	NNE F 4-5, moderate swell		

The back-up data buoy hull was shipped to Scalloway arriving on 3 December, where it was assembled over the next two days. The instruments and the processor were installed and tested over the period 13 to 16 December.

On 14 December the missing data buoy was recovered by the supply vessel Gorm Viking. It was adrift some 36 miles north of the deployment position. The buoy was taken back to Aberdeen where it was stored in the Mobil warehouse. It was inspected by Marex engineers on 22-23 December. Its general condition was good, and in particular the modules were undamaged.

On 9 January 1978, the mooring was recovered from the

offices of Viking Shipping, and inspection revealed that it too was in good condition except that the wire strop which connected the taut wire to the anchor weight was missing. Inspection of the data tape once again showed that no data had been recorded. On this occasion Marex had to wait a very long time before they could investigate the cause of failure. The processor module was lost in transit by British Rail, and it was not until 29 June 1978 that Marex reported it in their possession at Cowes. No obvious cause of failure has yet been identified, although tests are continuing. On 23 December an attempt to redeploy the data buoy had to be abandoned because of deteriorating weather. However, the next attempt was successful, and the buoy was deployed at 0300 GMT on 19 January 1978. The buoy was deployed from the Scottish Queen of North Star Fishing. The prototype processor was fitted.

A recurring problem throughout the project has been that the elderly trawlers, currently used as oil field standby vessels, which Marex use for deployment duties arrive at Scalloway late or in an unserviceable condition. In this instance the Scottish Queen sailed right past Scalloway on her way south, and had to steam back, arriving 24 hours late.

Deployment details were:

Time: 0300 GMT Date: 19 January 1978

Position: 60° 09'N
2° 58'W

Depth: 83 fm

Wind: SSE F7 rising

On 7 February our agent on Foula informed IOS that the signal from the data buoy was no longer present, and that the Waverider signal was very weak. IOS immediately informed Marex who arranged for the next service visit to be brought forward.

The service visit took place on 10 February. The data buoy was found moored on station but it had been run down and dismasted. The buoy hull was damaged, but the modules were intact. The buoy was towed into Scalloway where the buoy hull was repaired.

Subsequent inspection of the data tape showed that the buoy had been dismasted between 1300 and 1400 on 3 February when the recorded wind speed fell abruptly to zero.

The back-up Waverider was recovered, checked and redeployed on a new Marex mooring.

Deployment details were:

Time: 0610 GMT

Position: 60° 09'N
2° 59'W

Wind: SE 4

The Waverider signal was very weak during the following period (see Part 2).

The data buoy hull was repaired by 25 February, and during the following few days Marex engineers assembled and tested the instrumentation, and the completed system was ready for deployment on 1 March. However, the deployment vessel Grampian Queen arrived late with engine trouble, and with a gale forecast for the area it was decided to abandon the deployment attempt.

The next deployment attempt was planned for 18 March. Once again the deployment vessel was late, and moreover when it did arrive the compressors and the winch were inoperative. A gale warning was in force for the deployment area, and considering all the circumstances it was decided to abort the attempt.

The data buoy was successfully deployed at 2100 GMT on 1 April. On this occasion a smaller local seine-net fishing boat was used, and the Marex engineers were able to prove the practicability of this arrangement. Deployment details were:

Time: 2100 GMT Date: 1 April 1978

Position: 60° 08'N
2° 59'W

Depth: 88 fm

Wind: East F7

The position of the Waverider was checked but it was not serviced because the wave conditions were by this time quite severe.

PART 2 - The receiving station on Foula

The signal received from the data buoy during the latter part of September and October 1977 was very weak, and the last usable record obtained during this period was recorded on 17 October. An IOS party visited Foula during the period 23-26 October in order to check out the receiving and recording system and to install a 50W wind generator. It was found that all the equipment was operating satisfactorily, and subsequently our agent informed us that the generator was keeping the batteries well charged. However the signal from the data buoy was very weak.

On 9 November our agent informed us that he could hear no signal from the data buoy, and IOS immediately informed Marex. The buoy was subsequently found to have drifted off station (see Part 1).

On 25 November the back-up Waverider was redeployed although IOS was not informed until 28 November. IOS immediately contacted Foula and asked our agent to switch to the Waverider channel. This he did, and a good signal was found to be present. Good reception continued through December and into January 1978. However, our agent informed us that the data tape which normally takes only 4 weeks of data was still not full after 5 weeks. Fearing a tape recorder malfunction an IOS party visited Foula on 19 January to carry out equipment checks. These checks revealed that a triple-play tape had been mixed in with the normal double-play tapes by the tape supplier. Subsequent replay showed that the wave data had been correctly recorded on the triple play tape. However, in carrying out these tests the recording head was inadvertently contaminated, and it was not until 28 March that correct operation of the digital recorder was finally re-established. Fortunately, the back-up cassette recording system functioned reliably throughout this period, so that no data were lost due to the digital recorder problems (see Part 3).

The data buoy was deployed on 19 January, and the IOS party on Foula was able to check at first hand that the signals from both buoys were being received. Satisfactory signals were being received from both, although the signal from the Waverider was substantially stronger.

It was decided to receive the Waverider signal as routine. This was the reverse of the previous arrangement where the data buoy was received as routine, the Waverider signal being checked every few days when our agent visited the receiving site.

By the end of January both signals were again becoming rather weak, and on 7 February our agent informed IOS that neither signal could be heard. IOS informed Marex, who initiated a service visit to the buoy which took place on 10 February. On reaching the buoy site they found that the buoy had been run down and dismasted (see part 2). On that same day (10 February) we received confirmation from Foula that no signal was being received from the data buoy, although a weak signal from the Waverider was now present.

The signal received from the Waverider remained very weak, and IOS informed Marex of this on 27 February, 2 March and 13 March.

With the approach of Spring and quieter weather, the wind generator was not able to supply all the necessary power, so that some use of the petrol generator was necessary. The petrol generator had proved to be very unreliable and a replacement alternator was sent to Foula during early March.

The Marex data buoy was deployed on 1 April, and IOS informed on 3 April.

PART 3 - The Data

Scrutiny of data recorded on the buoy:

A brief description of the checking procedure employed by IOS on the data from the Marex buoy appeared in the second report, and this is reproduced in the present report as Appendix C.

The results of the checking procedure are shown in Table 2, an explanation of which is now given.

The table shows the percentage data loss for each element recorded, and for each of the three module periods. The periods covered by the modules are as follows:

Module No	Period covered
1	18 September - 4 November
2	4 November - 14 December 1977 when buoy found adrift
3	19 January 1978 - 10 February 1978 when buoy run down

In addition the table is subdivided into errors detected by Group 1 checks and those detected by Group 2 checks. An explanation of the data validation procedures employed is given in Appendix C. Briefly, Group 1 checks are simple checks on the data carried out by the computer to assess its reasonableness, while Group 2 checks involve comparisons with data from other sources. The letters A, B, C, D, E, F refer to the comments about the data listed below the table.

TABLE 2 - Marex buoy data summary (for explanation see text)

Module No	% data lost					
	Group 1			Group 2		
	1	2	3	1	2	3
RMS	100A	100B	8			
Hmax	100A	100B	3			
H_1	100A	100B	7			
T_z	100A	100B	9			
Wind speed	100A	100B	64C			
Wind direction	100A	100B	64C			F
Barometric pressure	100A	100B	0			100D
Air temperature	100A	100B	0			100E
Sea temperature	100A	100B	61C			

Comments on the data

A - No data were recorded during period 1 because of a leak in the processor module case (see Part 1 and Ref 1)

B - No data were recorded during period 2 - cause of failure not yet established

C - Buoy run down and dismasted after 15 days

D - Pressure data suspect throughout - 12 mb mean difference from LWC estimates for the area.

E - Air temperature data suspect throughout - 2°C mean difference from LWC estimate for the area.

F - Wind directions were recorded 180° in error due to compass installation fault. Marex instructed to recompute direction data.

Raw data recording

The on-buoy raw wave data recorder did not operate during the period of this report.

Foula (telemetered) data

Table 3 shows the percentage of data lost during each of the six periods between magnetic tape changes. The data loss has continued at a higher level than had been envisaged. Two clear patterns have emerged.

(1) When a freshly laboratory-serviced waverider buoy was deployed, for the following two months data retrieval was maintained at a high level.
(2) When the buoy output power had fallen so that reception in the face of interference was becoming difficult, most of the night-time records were retrieved while most of the day-time records were lost.

In view of (2) above, it seemed possible that some of the interference at least was originating locally, rather than from distant sources. An approach to the fishing authorities was made in August 1977, and in March 1978 a formal approach to Mr Woollen, secretary of the UKOOA Oceanographic Management Committee, was made to ask him to use his good offices to make the oil companies operating in the area aware of our problems.

During much of the period of this report, the digital recorder was not recording data successfully.

The back-up frequency modulated (f.m.) recorder operated reliably throughout the period, and while this meant that no data were lost, the work involved in the retrieval of the data from the f.m. tape record has caused some delay in the availability of the data.

TABLE 3 - Data recorded on Foula.

Period	% data lost	Comments
25 September - 26 October 1977	63	No usable data after 17 October
26 October - 28 November 1977	100	No system (see text)
28 November - 13 January 1978	14	Back-up W/R deployed
13 January - 14 February 1978	33	Back-up Recorder used from 19 January
14 February - 16 March 1978	40	Back-up Recorder used

REFERENCE 1

Technical and Operational Difficulties Experienced in the UKOOA Foula project, June to December 1977. IOS Internal Document No 30. May 1978.

APPENDIX A

Brief description of the Foula Data Buoy Project

The project is based on the use of the Marex data buoy which is moored at a site chosen to be in the same general area as the Fitzroy location and in a comparable depth of water, but close enough to land to enable the telemetry of wave data from the buoy.

The buoy makes hourly recordings of the following parameters:

Wave height
Wave period
Wind speed
Wind direction
Atmospheric pressure
Air temperature
Sea temperature

The computations involved are carried out by an onboard microprocessor and the results are recorded using a cassette type digital magnetic tape recorder.

The microprocessor and the tape recorder are housed in one of four replaceable waterproof modules, the batteries are housed in two others, and the Datawell heave sensor in the fourth.

The changing of the magnetic tapes and batteries is accomplished by simply exchanging the self-contained modules. This is done at approximately monthly intervals by Marex staff using a chartered fishing boat.

As well as being processed and recorded on the buoy, the wave data are transmitted continuously using a standard Waverider modulator and transmitter. A receiving station has been set up on the island of Foula which is switched on for 25 minutes once every 3 hours and during this time the signal is received and samples of the wave data are recorded using both analogue and digital tape recorders.

The receiving station is visited every few days by IOS's agent who is resident on the island, to check that the buoy signal is still being received. Battery charging is necessary once per week and the tapes are changed once per month. If for any reason the buoy signal is not received, our agent telephones IOS to discuss the problem and IOS in turn informs Marex. At the end of each month the tapes are transported to the mainland of Shetland for onward transmission to IOS.

As a back-up to the data buoy measurement of waves, Marex deployed a Waverider close to the buoy position. In the event of a failure of the data buoy transmission the Waverider can be received and recorded on Foula by selecting the appropriate channel on the receiver. In normal circumstances the Waverider signal is checked once every few days but is not sampled.

APPENDIX B

OVERALL DATA RETURN OF PROJECT

Summary Data Return Figures for the period 9 November 1977 to 12 July 1978

Data Type		Overall Percentage data return	
Wind		24	
Pressure		13	
Temperatures		3	
Waves (internally recorded on Marex Data Buoy)	25		
Waves (transmitted by Marex Data Buoy)	1 *		These figures refer to "fill-in' data derived from the IOS Foula series
Waves (transmitted by back-up Waverider)	30		
Total for waves		56	

*Note that wave data from the Waverider rather than the Marex data buoy are now recorded as routine on Foula (see text).

IOS Foula wave data

Overall percentage data return for the period 25 September 1977 to 12 July 1978 - 51

IOS Taunton

11 August 1978

APPENDIX C

Description of IOS data checking procedure

In order to operate the 'continuity of operations' clauses in the contract, it was necessary for IOS to develop a checking procedure to be used on all the data buoy results. As well as having purely contractual use, this work was important in that the performance of the buoy, which was a comparatively untried system, was monitored closely and recommendations regarding specific aspects of its performance could be made as necessary.

Briefly, the checking scheme used was as follows. A copy of each buoy data tape was sent to IOS by Marex. This was checked by a computer program to determine how much of the data was retrievable, and how much of the retrievable data passed some simple checks for reasonableness. These we refer to as 'Group 1 checks' - see ref C1.

In addition comparisons were made:

(a) between the wave data recorded on the buoy, and the wave data recorded on Foula; and

(b) between the meteorological data recorded on the buoy and estimates of the meteorological conditions at the buoy site prepared by the Meteorological Office (London Weather Centre) using the appropriate synoptic charts.

These comparisons we refer to as 'Group 2 checks' - ref 1.

The results of these procedures were used in the following way:

1. We used the Group 2 checks to assess the general performance of the buoy. In particular we could detect any systematic errors. If there were errors, depending on the nature of these, we either disqualified the data (for payment) or accepted it, but in any case asked that Marex qualify the data as being erroneous or suspect.

2. If we considered that as a result of the Group 2 checks the data were useful, then the results of the Group 1 checks were used to determine the data return figures to be used contractually.

Reference C1

Pitt, E G. 'The Quality Control of Data from an Offshore Station'. Symposium on Offshore Data Acquisition Systems, Southampton September 1974. SUT.